Adopted January 21, 2003

Wake Forest

Transportation Plan

Kimley-Horn
and Associates, Inc.

Acknowledgments

Advisory Group

Rob Bridges, Commissioner
Velma Boyd, Commissioner
Einar Bohlin, Planning Board
Sherrill Brinkley, Planning Board
Christa Greene
Ryan Hutchison
Ann Hines
Rob Weintraub
Stephen Barrington
Fred Amos
John Rich
Vincent Jones

Board of Commissioners

Vivian Jones, Mayor
Velma Boyd
Chris Malone
Rob Bridges
Kim Marshall
David Camacho

Planning Board

Sherrill Brinkley, Chairman
Al Merritt
Speed Massenburg
Frank Drake
Einar Bohlin
Bob Hill
Sue Holding
Bob Sobol
Mike Penney
Mike Berry

Town Staff

Chip Russell, Planning Director
Eric Keravuori, Director of Engineering

Project Consultants

Roger Henderson
David Whyte
Teresa Frusti

- Kimley-Horn & Associates, Inc

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Introduction and Vision

WHY DEVELOP A NEW TRANSPORTATION PLAN?

The Town of Wake Forest's thoroughfare plan that was adopted in 1986 is outdated.

Since 1990, Wake Forest has experienced significant population growth (more than 118%). The town has added new businesses, expanded shopping opportunities, and developed more venues for entertainment, but not without cost. While these increases have provided positive growth for the community, they have also increased traffic on the roads, adding to existing congestion and new traffic pressure points throughout the town. As the pace of growth continues within the town and in surrounding areas, accommodating increases in traffic will become increasingly important in order to maintain the mobility of Wake Forest's citizens.

The *Wake Forest Transportation Plan* identifies specific and general transportation system improvement recommendations and strategies to help accommodate growth in travel demand, while supporting a diversified transportation system that considers not only the automobile, but also the cyclist, the pedestrian, and the transit patron. A plan that does not consider implementation is faulted from the start. With this in mind, the *Wake Forest Transportation Plan* includes discussion on strategies, methods, and sources of funding for implementation.

Wake Forest has an adopted *Land Development Plan* (adopted in 1985)and a *Land Use Management Plan* (adopted in 1997) as well as a *Greenway and Open Space Master Plan* (adopted in 2002). Recommendations in this transportation plan consider each of these plans.

The study area for the plan is Wake Forest's urban services area (USA): the area that can be expected to be served (in the future) by services from the town. This is also an area in which Wake Forest can reasonably be able to create change. The study area is shown in **Figure 1.1**.

Wake Forest
Transportation Questionnaire
Survey Results (rank order)

Top Priorities

1. *Complete the NC 98 bypass of downtown/NC 98 (14 first place votes)*
2. *Widen South Main St. from north of Holding Ave. to Capital Blvd. (8 first place votes)*
3. *Fix the traffic jam near the Seminary (railroad underpass) (6 first place votes)*
4. *Construct a sidewalk on Durham Rd. between US 1 and Wingate St. (2 first place votes)*
5. *Provide/support initiatives for rail and bus service to Raleigh, RTP, and other important destinations (2 first place votes)*
6. *Extend Ligon Mill Rd. north (4 second place votes)*
7. *Construct sidewalks on North Allen St., north of Wait Ave. (2 second place votes)*
8. *Landscaping and streetscape (4 third place votes)*

Sample of Responses on Citizens' Transportation Priorities in Wake Forest

Traveling Trends

People today drive more often, make longer trips, and own more vehicles than ever before. In 1969, households made an average of 3.83 trips per day, in 1995 that number rose to 6.36 trips per day, an increase of 2 ½ trips per household or 66%[1]. This is despite the fact that average household size has decreased from 3.16 to 2.63 persons per household since 1969.

PUBLIC INVOLVEMENT

Transportation planning has become a more inclusive process that builds on strong citizen involvement. Historically, transportation planners did not think that the public would either be interested in or understand long-term planning studies and issues.

Citizens have an intimate knowledge of the places where they live and travel and the transportation problems they encounter. To make sure that the *Wake Forest Transportation Plan* considered citizen concerns, while also keeping the community's best interest in mind, a Citizen Advisory Group (CAG) was formed and engaged early in the planning process.

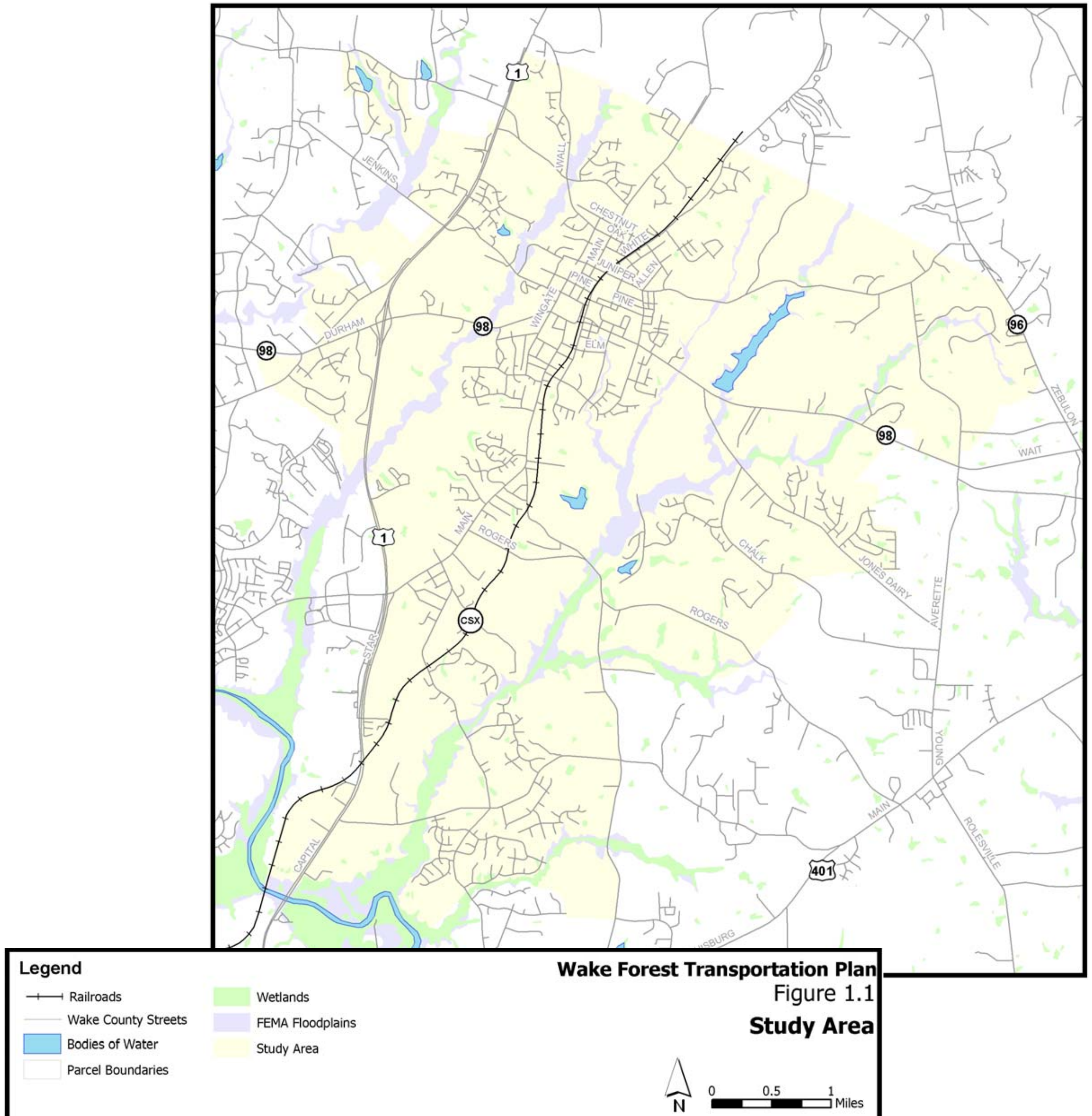
The first task undertaken by members of the CAG was to generate a list of the characteristics that they like in Wake Forest and would want to retain in their community. Likes included the small town charm, convenience, attractiveness, and overall atmosphere of Wake Forest. The committee members agreed that they wanted to retain each of these things while also promoting a plan that would put a variety of land uses within easy reach of Wake Forest's citizens.

VISION AND OBJECTIVES

Keeping in mind the elements that make Wake Forest a special place, the CAG envisioned the future transportation system. To guide the overall development of the transportation plan, objectives were developed that include (in no particular order):

- Develop a plan compatible with future land use plans and adjacent jurisdictions' plans
- Create a plan that accommodates community growth and its related traffic increases
- Create a system of interconnected streets (thoroughfares, collectors, and local streets)
- Preserve future transportation corridors
- Maintain and improve roadway safety

[1] Source*: 1995 Nationwide Personal Transportation Survey*, Office of Policy Information, United States Department of Transportation (USDOT), Federal Highway Administration (FHWA)



Wake Forest Transportation Plan
Figure 1.1
Study Area

- Relieve existing congestion on key roadways
- Create interconnected bicycle and pedestrian networks
- Provide and plan for future transit service expansions
- Provide more downtown parking
- Minimize cultural and environmental impacts
- Retain old growth trees throughout the town

Wake Forest—a member of the Capital Area Metropolitan Planning Organization (CAMPO)—was involved in the development of regional transportation goals and objectives. Understanding the importance of these, Wake Forest—as a part of this transportation plan—is adopting CAMPO's vision and goals. These are summarized in this chapter and are also included in their entirety in **Appendix B**.

CAMPO Vision

A multi-modal transportation network that is compatible with our growth, sensitive to the environment, improves quality of life, and is accessible to all.

CAMPO Goals

- *Develop a regional transportation network that improves the quality of life and the environment*
- *Provide convenient, safe, reliable, and affordable transportation choices*
- *Provide public education on transportation choices*
- *Enhance connectivity by developing a multi-modal transportation network that promotes economic growth compatible with the environment and land use patterns*
- *Develop an efficient transportation network that is both affordable and reliable for the movement of people and goods*

A Transportation Planning Guide

The vision of a safe, multi-modal, and interconnected transportation system for Wake Forest can become a reality. This plan is intended to serve as a tool and guide for the future success in the implementation of Wake Forest's transportation system. 2025 is the planning horizon for the transportation plan. The *Wake Forest Transportation Plan* includes the following chapters:

- Existing Conditions
- Future Conditions
- Recommended Thoroughfare Plan
- Pedestrian and Bicycle Element
- Transit Element
- Implementation Plan

Existing Conditions

North Main Street near Cedar Avenue

INTRODUCTION

The Town of Wake Forest is located in northern Wake County along highways US 1 and NC 98. An established community, Wake Forest has traditional neighborhoods laid out on a grid of interconnected streets at its core with more rurally and suburban oriented development on its outer fringes. The town has a vibrant historic downtown, with bustling businesses in preserved and restored storefronts.

Today, Wake Forest is primarily a bedroom community with limited large-scale commercial development and major employers. As such, the majority of traffic generated during peak travel periods is attributed to commuters traveling to the region's employment centers such as Research Triangle Park (RTP) and downtown Raleigh. Other peak hour traffic generators in the town include the Southeastern Baptist Theological Seminary, Wake Forest-Rolesville High School, Wake Forest-Rolesville Middle School, Wake Forest Elementary School, Franklin Academy, and Jones Dairy Elementary School. In the future, increases in traffic may come from planned (and in some parts under construction) large development projects such as the Wake Forest Crossings Shopping Center and the Heritage Wake Forest Development as well as from numerous apartment complexes and subdivisions.

The purpose of evaluating today's transportation system is to understand what must be fixed today. Community profile data described in this chapter include the following:

- Population
- Employment
- Transportation Corridors and Activity Centers
- Regional Access
- Major Thoroughfares
- Minor Thoroughfares
- Collector Streets
- Corridor Operations
- Intersection Levels of Service
- Traffic Safety and Crash History

POPULATION

According to the United States Census Bureau, Wake County's population increased 43.8 percent between 1990 and 2000 from 423,380 to 608,654 persons—a difference of about 185,000 people. During the same period, the population of Wake Forest grew by more than 118 percent, from 5,769 to 12,588 persons.

EMPLOYMENT

Between 1992 and 2002, according to the U.S. Bureau of Labor Statistics, total employment in the Triangle region increased 31 percent from 483,204 to 633,260—an increase of more than 150,000 jobs. With the influx of new jobs throughout the 1990s, the Triangle's unemployment rate decreased from 4.2 percent in 1992 to a 10-year low of 1.6 percent at the end of 2000. As a result of the downturn of the economy, unemployment has again risen (region wide) to above 4.5 percent (January 2002).

TRANSPORTATION CORRIDORS AND ACTIVITY CENTERS

Transportation is primarily focused along roadway corridors and within activity centers. In a community's development (land use) plan, centers and corridors are the links between home, school, job, shopping, social, and recreational destinations. The extent to which these origins and destinations are blended into multi purpose activity centers will have dramatic effects not only on the ability for people to choose whether to walk, bike, drive, or ride a bus, but also more importantly on how they perceive their communities to be "livable."

REGIONAL ACCESS

Regional access to Wake Forest is provided by three major thoroughfares as shown in **Figure 2.1**. These include US 1 (Capital Boulevard), NC 98 (Durham Road/Wait Avenue), and US 401 (Louisburg Road).

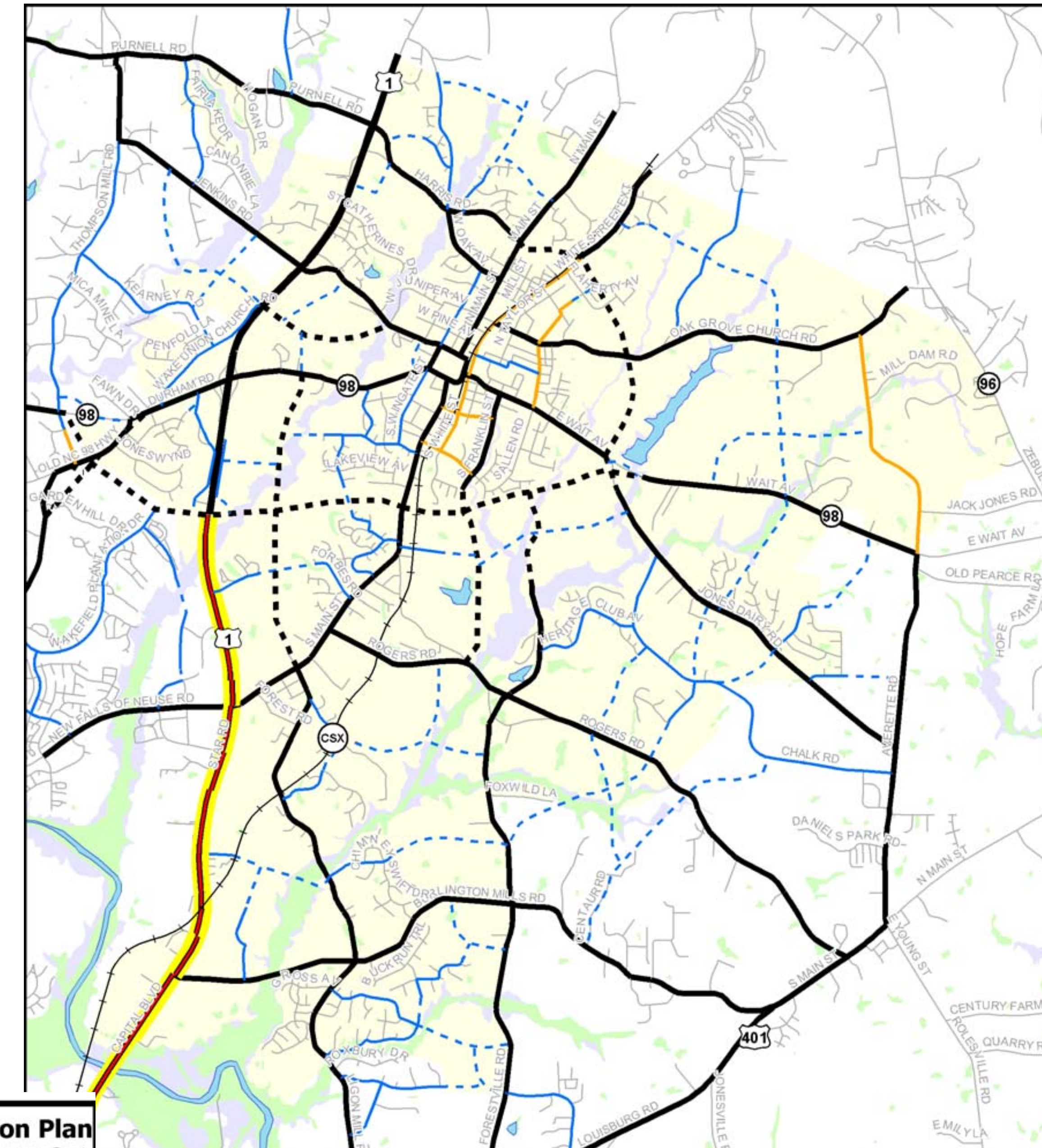
Capital Boulevard (US 1) is a primary north/south corridor for the Triangle. Through Wake Forest, it is a four-lane divided highway with a mixture of unsignalized and signalized intersections, including one interchange, located at NC 98, and another that is anticipated to be completed for the NC 98 bypass by 2008. Posted speed on Capital Boulevard throughout the study area is 55 mph. **Table 2.1** indicates approximate completion dates for the NC 98 bypass.

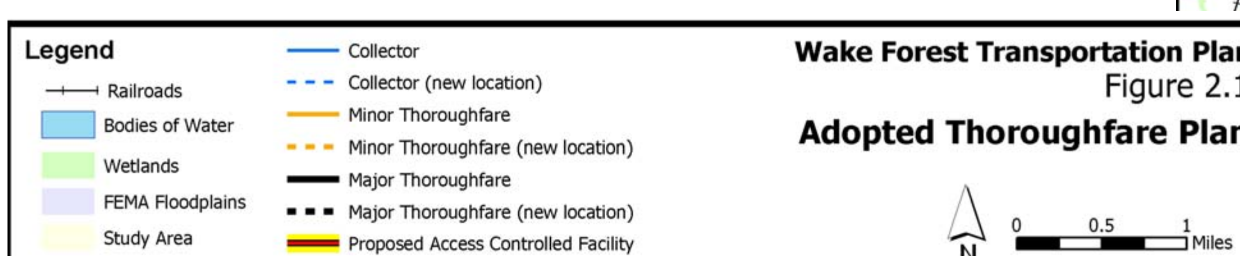
Table 2.1—Approximate Completion Dates for the NC 98 Bypass

Section	Year
East Wait Avenue to South Main Street	Late 2004
South Main Street to US 1 (Capital Boulevard)	2008
US 1 (Capital Boulevard) to Durham Road	2012

NC 98 (Durham Road/Wait Avenue) is predominantly a two-lane major thoroughfare that runs east/west and passes through downtown Wake Forest on its way to Durham. Throughout its length, NC 98 changes character from a rural two-lane highway with posted speeds of up to 55 mph to a busy downtown street where speeds rarely exceed 25 mph.

US 401 (Louisburg Road) is a rural two-lane highway with posted speeds of up to 55 mph that runs along Wake Forest's southeastern edge. US 401 is a popular route for commuters traveling to Raleigh. Improvements recently completed included the widening of US 401 to a four-lane divided highway from Ligon Mill Road to US 1.





Wake Forest Transportation Plan
Figure 2.1
Adopted Thoroughfare Plan

Major Thoroughfares

Major thoroughfares in the Wake Forest area include streets that serve medium to long distance travel and connect minor thoroughfares and collector streets to freeways and other higher type roadway facilities. For the most part, roadway improvements and maintenance on major thoroughfares are funded by the North Carolina Department of Transportation (NCDOT). Roads that are currently designated as major thoroughfares in the Wake Forest area include:

- Averette Road
- Burlington Mills Road
- Forestville Road/Heritage Lake Road
- Franklin Street
- Harris Road
- Jenkins Road
- Jones Dairy Road
- Ligon Mill Road
- NC 96 (Zebulon Road)
- NC 98 (Durham Road/Wait Avenue)
- Oak Grove Church Road/East Juniper Avenue
- Purnell Road
- Rogers Road
- Stadium Drive
- US 1A (South Main Street/North Main Street)
- West Oak Avenue

Some of these roads are common travel routes to neighboring communities such as NC 96 (Zebulon Road) to Zebulon, Averette Road to Rolesville, and NC 98 (Durham Road) to Durham.

Minor Thoroughfares

For the most part minor thoroughfares are maintained by NCDOT, but the cost of improvement is typically the responsibility of local governments. These roads primarily serve a local travel purpose and often connect to other minor thoroughfares as well as major thoroughfares. In Wake Forest, minor thoroughfares are mostly two-lane undivided roads with little or no paved shoulders and the occasional left-turn lane at major intersections and driveways. Posted speed limits on minor thoroughfares range from 25 mph to 45 mph. Other characteristics include sidewalks (on some), signalized intersections, and on-street parking (in residential areas and on downtown streets). Minor thoroughfares in Wake Forest include:

- North and South White Streets
- North Allen Road
- Elm Avenue
- East Holding Avenue

Collector Streets

The main purpose of the collector street system is to “collect” traffic from neighborhoods and distribute it throughout the town, either to the system of collector streets or to other thoroughfares. In general, collector streets have two lanes and some have exclusive left-turn lanes at busy intersections. In general, collector streets are not part of the state maintained system of roads. Collector streets in Wake Forest have a wide range of physical characteristics, some of which are attributable to the neighborhoods in which they exist. Though different, the one shared commonality is that of providing good connections. Collector streets in Wake Forest are shown in **Figure 2.1**.

Corridor Profiles

To provide additional information, a profile of each corridor is presented in **Appendix A**. Included for each corridor is a photograph, information on traffic volumes, and relevant roadway characteristics.

Narrow Railroad Undercrossing on East Roosevelt Avenue

Corridor Operations

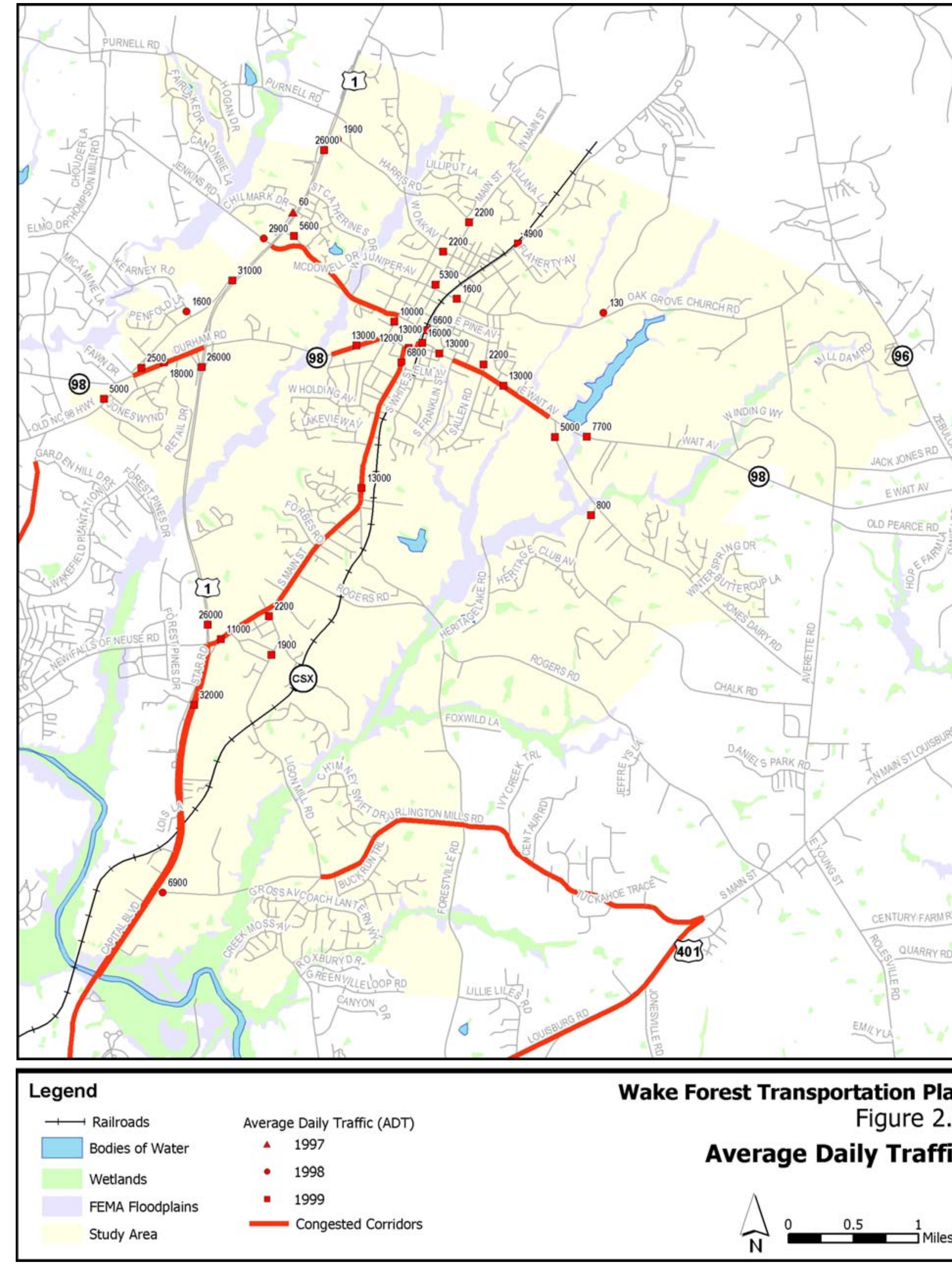
Congestion in corridors is related to a number of factors, but is most often the result of bottlenecks—primarily at intersections—along the corridor. Aside from individual bottleneck locations in corridors, congestion is frequently the result of too many people trying to use a route that is already full—either at or over capacity. Several of Wake Forest's streets are over capacity at peak hours. **Figure 2.2** illustrates average daily traffic (ADT) volumes in study corridors. Corridors that displayed noticeably high ADT's or were found to experience significant congestion were sections of the following:

- Capital Boulevard (US 1)
- Durham Road (NC 98)
- Stadium Drive
- South Main Street (US 1A)
- Burlington Mills Road

Table 2.2 also indicates selected ADT's on roadways thoughout the study area.

Table 2.2—Study Area Average Daily Traffic

Location	ADT
US 1	
-south of South Main Street	32,000
-between South Main Street and NC 98	26.000
-between NC 98 and Stadium Drive	31,000
-north of Stadium Drive	26,000
South Main Street	
-between US 1 and Rogers Road	11,000
-between Rogers Road and Holding Avenue	13,000
-north of Holding Avenue	6,800
North Main Street	
-North of North Avenue	5,300
Stadium Drive/Jenkins Road	
-west of US 1	2,500
-between US 1 and Wingate Street	5,600
Durham Road	
-between Old NC 98 and US 1	18,000
-between US 1 and Wingate Street	13,000
East Wait Avenue	
-between Front Street and Franklin Street	16,000
-between Franklin Street and Jones Dairy Road	13,000
-east of Jones Dairy Road	7,700
North Avenue	6,600
South Avenue	12,000



Traffic at Front Street/East Roosevelt Avenue

Level of Service Key

- *A, B, C = Minimal delay*
- *D = Maximum acceptable delay*
- *E = Approaching capacity (unstable)*
- *F = Demand exceeds capacity, stop-and-go conditions*

Intersection Levels of Service

Traffic safety and congestion concerns are often most acute at intersections. For this reason, the *Wake Forest Transportation Plan* includes a discussion of key intersections.

Studied intersections, listed in **Table 2.3,** include a level of service (LOS) rating that is used to describe operating conditions for motorists. As with school grades, LOS A denotes good performance with little or no delay. Failing intersections where the average delay getting through the intersection exceeds 85 seconds per vehicle are rated LOS F. Wake Forest roadways operating at LOS D or better are considered acceptable from a motorist's perspective.

Information used to determine level of service at the listed intersections include the number of vehicles traveling through or turning, the number of lanes for each turning movement, traffic signal phases, signal "green time" allocation, and factors related to bus stops and pedestrian crossings.

Table 2.3—Study Intersection Levels of Service (LOS)

Intersection	AM Peak Hour Level of Service	PM Peak Hour Level of Service
Capital Blvd (US 1)/Purnell Rd/Harris Rd	D[1]	B[1]
Capital Blvd (US 1)/Jenkins Rd/Stadium Dr	F	B
Capital Blvd (US 1)/Wake Union Church Rd	A	B
Durham Rd (NC 98)/Thompson Mill Rd	n/a	E[2]
Durham Rd (NC 98)/Cloverleaf Dr	n/a	D[2]
Durham Rd (NC 98)/US 1 Southbound Ramp	n/a	C[2]
Durham Rd (NC 98)/US 1 Northbound Ramp	n/a	C[2]
Burlington Mills Rd/Forestville Rd	C[3]	B[3]
Louisburg Rd (US 401)/Forestville Rd	B[3]	A[3]
Burlington Mills Rd/Ligon Mill Rd	B[3]	B[3]
Wingate Street/Durham Road/South Avenue[4]	C	C
Wingate Street/North Avenue/Stadium Drive[4]	C	C
South Main Street/South Avenue[4]	C	C
Front Street/East Roosevelt Avenue[4]	F	F
White Street/East Roosevelt Avenue[4]	F	F

n/a: Not available
All counts taken in March 2000 unless otherwise noted

1. Counts taken in July 2001 2. Counts taken in September 1999 3. Counts taken in March 2001 4. Counts taken in September 2002

Kimley-Horn and Associates Inc., 2002

Congested Study Intersections

Capital Boulevard/Jenkins Road/Stadium Drive—The Capital Boulevard (US 1)/Jenkins Road/Stadium Drive intersection experiences unacceptable vehicle delays on one or more approaches during the AM peak hour resulting in a LOS F. At this location, Capital Boulevard (US 1) is four lanes with exclusive left-turn lanes northbound and southbound as well as a northbound exclusive right-turn lane. The eastbound (Jenkins Road) and westbound (Stadium Drive) approaches each have an exclusive left-turn lane and shared through/right-turn lane.

In the AM peak hour, a primary contributor to the overall failure of the intersection is the westbound (Stadium Drive) left-turn movement that extensively queues on Stadium Drive. The heavy traffic volumes traveling southbound during the AM peak hour limits the amount of green time that can be provided to this movement, and the large percent of vehicles traveling eastbound through the intersection reduces the gaps necessary for permissive left turns, resulting in long delays for westbound vehicles. To mitigate the unacceptable level of service on the westbound approach it will be necessary to construct an additional exclusive westbound left-turn lane as well as to revise signal timing and phasing to allow the eastbound and westbound approaches to function in a split-phase operation.

Front Street/East Roosevelt Avenue and White Street/East Roosevelt Avenue—Both of these signalized intersections experience unacceptable vehicle queues and delays during peak hours. In the AM peak hour, vehicle queues form on eastbound East Roosevelt Avenue. In the PM peak hour, vehicle queues form on northbound Front Street. Traffic congestion at these location is a result of too much traffic traveling through intersections, severe geometric constraints, and signal timing constraints. The roadway undercrossing (under the railroad) is only wide enough for three lanes, one through lane in each direction and a two-way left-turn lane. With a full-movement signalized intersection at both ends of the undercrossing, left-turn storage and carefully coordinated signal phasing and timing are necessary. Unfortunately, there is inadequate left-turn storage, which creates limitations in maximizing signal timing at both intersections.

Mitigation measures at these locations would include restricting turning movements at both intersections. While this would improve intersection operations, the inconvenience it would cause Wake Forest's residents outweighs the opeational improvement it would provide during peak travel periods of the day. In the next 10 years, both of these intersections as well as other intersections on the NC 98 route through Wake Forest's downtown are likely to be improved through a reduction of through traffic (traffic not bound for Wake Forest) due to the completion of the NC 98 bypass.

Looking West toward Burlington Mills Road from Ligon Mill Road

Looking East toward Harris Road from Capital Boulevard

TRAFFIC SAFETY AND CRASH HISTORY

Crash data maintained and provided by the North Carolina Department of Transportation were summarized for this study. From January 1998 to August 2001, the Wake Forest intersection with the highest crash frequency was Capital Boulevard (US 1)/Jenkins Road/Stadium Drive, which experienced 25 total crashes or approximately 7 crashes each studied year. During the same time period, the intersection with the highest crash rate was Ligon Mill Road/Burlington Mills Road. Overall data indicated that four intersections had a yearly average of more than 5 collisions. Only one crash fatality, at the intersection of Capital Boulevard and Purnell Road, was reported in Wake Forest during the studied time period.

The Wake Forest intersections with the highest crash frequency (from January 1998 to August 2001) are shown in **Table 2.4**.

Table 2.4—Intersections Ranked by Crash Frequency

Rank	Location	Crash Frequency (Crashes/Year)
1	Capital Blvd (US 1)/Jenkins Road/Stadium Drive	25
2	Ligon Mill Road/Burlington Mills Road	23
3	S. Main St (US 1A)/Capital Blvd (US 1)	21
4	Capital Blvd (US 1)/Burlington Mills Road	18
5	Capital Blvd (US 1)/Purnell Rd/Harris Rd	15
6	Wait Avenue (NC98)/Averette Road	12
7	Harris Road/Oak Avenue (W. Wall Road)	9
8	Durham Road (NC 98)/Thompson Mill Road	8
9	Capital Blvd (US 1)/0.10 miles south of US 1A	8

Source: North Carolina Department of Transportation

There is a direct relationship between traffic congestion and crash frequency, providing impetus to ongoing efforts to provide adequate funding for transportation projects that minimize traffic congestion.

Ranking intersections by crash frequency is one method of identifying high crash locations, but it is also important to consider crash rate when identifying high crash locations. By applying an exposure, which takes into account the volume of vehicles in the time surveyed, a rate (number of crashes per 100 million entering vehicles) can be calculated. By using rates, new locations are often identified as high crash locations. **Table 2.5** indicates the highest crash rate intersections identified for Wake Forest.

Table 2.5—Intersections Ranked by Crash Rate

Rank	Location	Crash Rate (Crashes/100 MEV)
1	Ligon Mill Road/Burlington Mills Road	2740
2	Capital Blvd (US 1)/Purnell Road/Harris Rd	803
3	Capital Blvd (US 1)/Burlington Mills Road	803
4	Capital Blvd (US 1)/Jenkins Rd (Stadium Dr)	803
5	S. Main Street (US 1A)/Capital Blvd (US 1)	622
6	Harris Road/Oak Avenue (W. Wall Road)	581
7	Wait Avenue (NC 98)/Averette Road	458
8	Durham Road (NC 98)/Thompson Mill Road	393
9	Old NC 98/Durham Road (NC 98)	348

100 MEV = 100 Million Entering Vehicles (the intersection)

Comparing **Table 2.4** with **Table 2.5**, the top five high frequency intersections are also those intersections with the highest crash rates. This correlation between tables is a good indication that the high crash locations identified are true problem areas. These locations would benefit from further crash analysis to determine measures that may increase safety.

Two crash types, angle and rear-end, occurred commonly at each of the five high crash locations. *Angle crashes* are often the result of drivers misjudging the speed and/or distance of oncoming traffic and mistakenly turning in front of or into an oncoming vehicle. This crash type is likely to occur in the following situations:

- When drivers disregard or fail to see a traffic control device, such as a Stop or Yield sign or traffic signal
- When inadequate sight distance exists due to a physical obstruction or geometric condition (e.g., steep grade or sharp curve)

Angle collisions in Wake Forest were found to be prevalent at intersections with short sight distance and/or protected-permitted left-turn phasing. Protected-permitted left-turn phasing allocates a portion of an approach's "green-time" for the exclusive movement of left-turning vehicles and then transitions to allow left-turning traffic to run concurrently with through traffic on an opposite approach. During the concurrent phase left-turning vehicles must yield to oncoming through vehicles.

Rear-end crashes commonly occur at locations that experience periods of congestion. They are often the result of sudden stops coupled with inadequate following distance, two all too common occurrences during periods of traffic congestion.

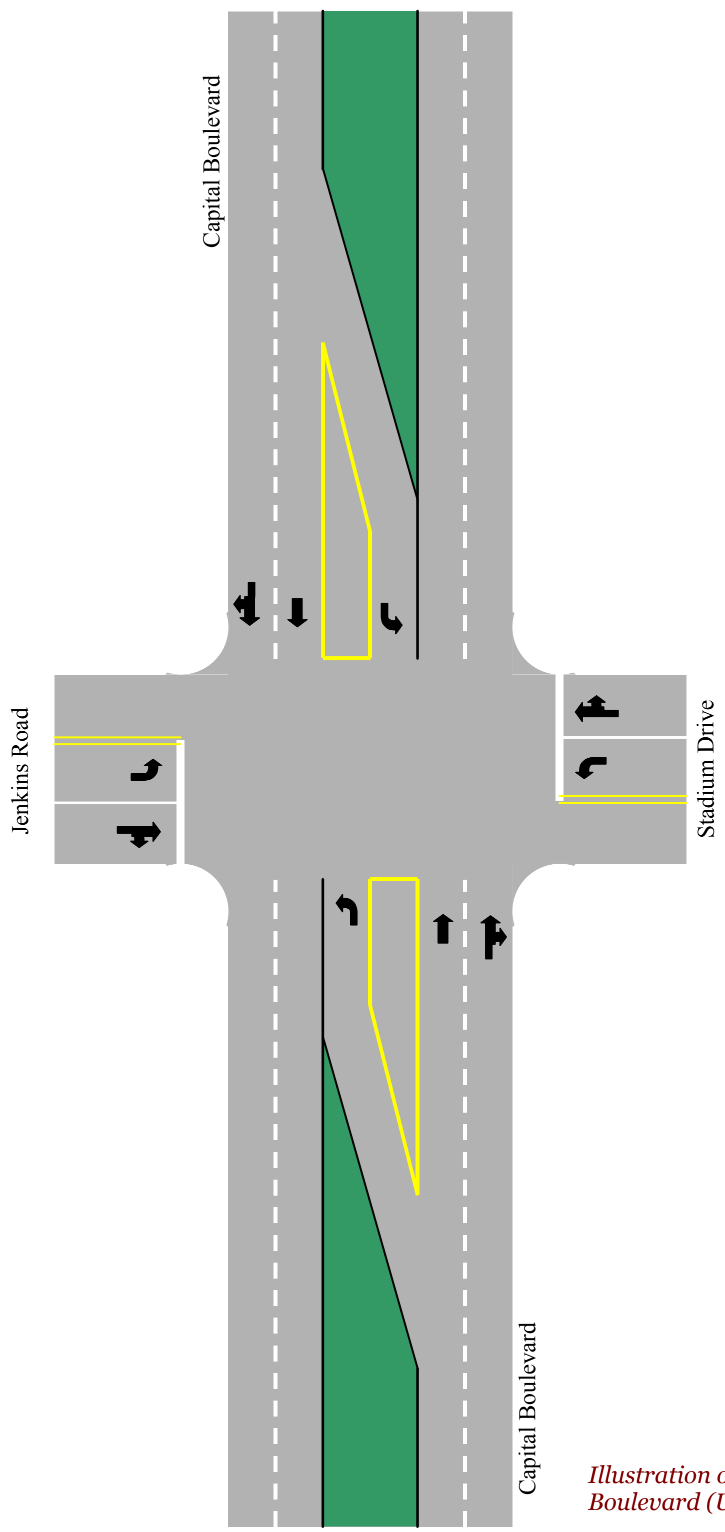


Illustration of an Offset Left-Turn Treatment on Capital Boulevard (US 1)

Capital Boulevard (US 1)/Jenkins Road/Stadium Drive—This signalized intersection was found to experience the highest crash frequency and the fourth highest crash rate in the study area. Of the 25 crashes that occurred at this location, 19 were angle crashes (76%), 11 of which resulted in injuries. Sight distance in the northbound and southbound directions are adequate. At this location, it appears that drivers have a lesser issue of sight distance and a greater issue of judging the distance and speed of oncoming traffic before making a permissive left-turn. Possible countermeasures to mitigate this crash type include altering signal phasing to allow only protected left-turns northbound and southbound and reconstructing the left-turn bays to offset one another to reduce the crossing distance and increase sight distance for drivers making permissive turning movements. The diagram below illustrates the reconstructed offset left-turn bays.

Although revising the signal phasing to disallow permitted left-turns would dramatically reduce the frequency of angle collisions at this location, it would impact northbound/southbound left-turn capacity. From analysis it does not appear that this modification to signal phasing will degrade overall intersection level of service.

Ligon Mill Road/Burlington Mills Road—This intersection had a total of 23 reported crashes, 22 of which were angle crashes. The majority of crashes reported at this location involved property damage only and occurred prior to August 2000 (19 crashes). At the end of July 2000, a traffic signal was installed at this location. Since then, both the rate and frequency of crashes have decreased significantly; there have only been four crashes. Because the traffic signal appears to have mitigated the acute safety problem of limited sight distance, no other countermeasures are recommended at this time for this intersection.

South Main Street (US 1A)/Capital Boulevard (US 1)/New Falls of Neuse Road—Capital Boulevard intersects New Falls of Neuse Road to the west and US 1A (South Main Street) to the east at this signalized intersection. Traffic volumes are heavy in all directions, especially during AM and PM peak hours. Of the 21 total crashes, 16 (76%) were angle crashes, injuring 9 people. With current geometry and the presence of a traffic signal, no other mitigation measures are recommended.

Capital Boulevard (US 1)/Burlington Mills Road—This signalized T-intersection is located at the southwest corner of the study area. Angle crashes were the most common crashes occurring at this location, contributing to 50% of all crashes at this location. Rear-end crashes were the second most prevalent, comprising 28% of all crashes. It is likely that the majority of rear-end collisions are the result of inadequate following distance coupled with the signal changing to red as vehicles approach the signal. No cost effective mitigation measure can be recommended to remedy this crash type in this situation. The angle collisions that are occurring are likely the result of impatient drivers who misjudge the speed or distance of oncoming traffic and are struck by a vehicle. Again, with the signal already in place, no other good mitigation measures would be likely to reduce the number of crashes at this intersection. While restricting left-turning movements to a protected only phase is a potential improvement, it is not recommended at this time due to the minimal effect it would provide.

Capital Boulevard (US 1)/Purnell Road/Harris Road—This signalized intersection is the northernmost access point to Wake Forest from US 1. At this location, Capital Boulevard is a four-lane divided highway with an exclusive left-turn lane and right-turn lane in both the northbound and southbound direction. The eastbound (Purnell Road) and westbound (Harris Road) approaches to the signalized intersection have a shared through-right turn lane and an exclusive left-turn lane. During the past 45 months, 15 crashes have occurred at this intersection, 11 of which involved injuries and one of which resulted in a fatality. While one fatality is cause to carefully examine intersection operations and safety, the circumstances of the fatal crash provide little indication of how intersection modifications could have prevented the occurrence. No mitigation measures are proposed for this intersection.

Future Conditions

INTRODUCTION

Taking into consideration statistics from recent years, it is safe to say that Wake Forest will continue to grow. Existing open spaces will be developed into residences as well as some offices and shops. In some cases developed areas will be redeveloped. 2025 population forecasts for Wake County indicate a total population that will exceed 1.2 million people. Growth to this level means that the current (2002) county population will nearly double, adding more than 620,000 people in the next 23 years. With such tremendous growth anticipated in the next 23 years, Wake Forest will certainly be a contributor to this growth.

Inevitably, growth of this magnitude means that issues will arise that need to be given careful consideration in planning the changes to Wake Forest's transportation system. Important background information in this chapter includes the following:

- Growth Areas
- Journey to Work
- NC 98 Bypass
- Modeling and Forecasts
- Natural Environment

To address the issues arising from growth trends, travel behavioral trends, constraints due to the natural environment, and constraints due to already planned projects in the county, the Triangle Regional Model was used. From the model, projected future travel demand was developed, important key travel corridors were identified, and study alternatives were evaluated.

Growth Areas

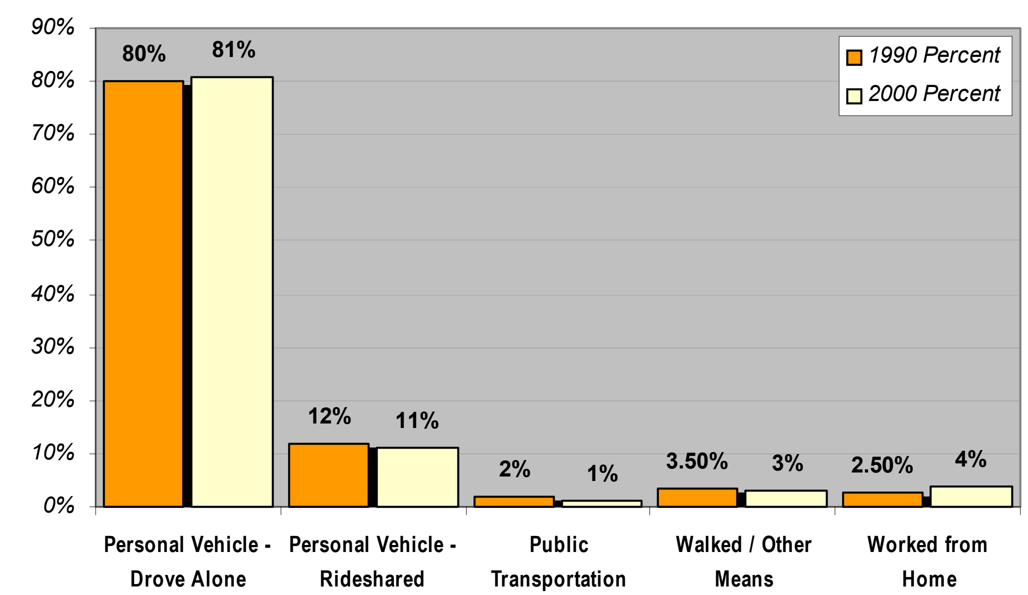
Wake Forest will continue to grow. New residents will make Wake Forest their home, some employers will expand, and new employers will move to the town. By far the the greatest numbers of people and jobs will be added at the Wake Forest's suburban fringe; however, growth will also occur through annexation and infill development.

Journey to Work

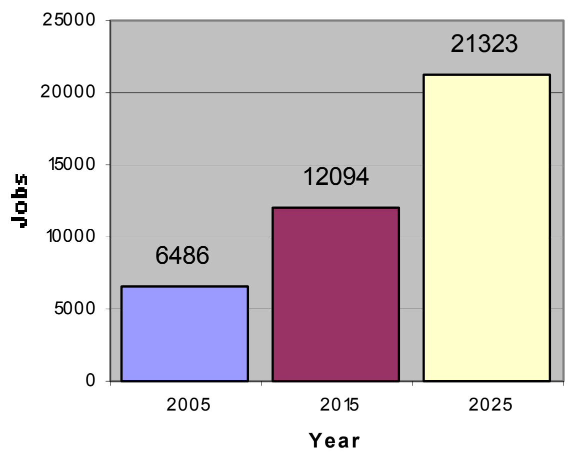
Household travel surveys—part of the 1990 Census and the 2000 Census—summarize commuting characteristics for Wake County residents. The overwhelming majority—more than 80% of all survey respondents—reported traveling to work by driving alone.

Over the last 10 years, a decline has occurred in the proportion of work trips made using transit, carpools, and means other than a personal automobile to travel to work. In 1990, the average travel time for a Wake County resident to travel to work was 20 minutes—by 2000 that time increased to 25 minutes. One encouraging statistic is that a larger percentage of work trips are not being made at all because a greater number of people have chosen to telecommute.

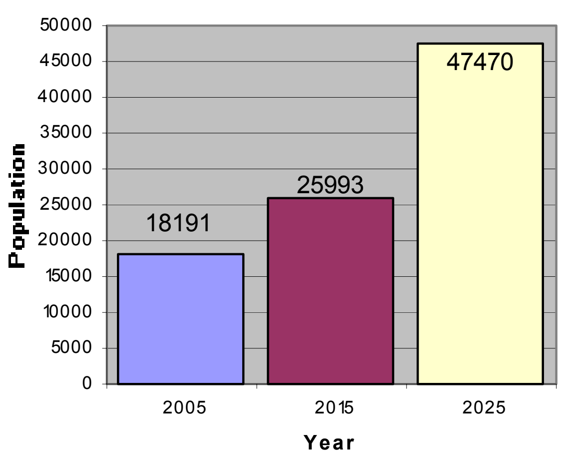
Although journey to work statistics were not explicitly summarized for Wake Forest, it can be expected that Wake Forest residents have similar travel characteristics to other Wake County residents.



Journey to Work Summary



Modeled Employment Forecasts for Wake Forest



Modeled Population Forecasts for Wake Forest

NC 98 Bypass

NC 98 Bypass (R-2809)—This multi lane facility will be constructed on new location from NC 98/Thompson Mill Road to Jones Dairy Road/East Wait Avenue. The project is 4.7 miles long and has an estimated cost of $62 million.

Table 3.1—Approximate Completion Dates for the NC 98 Bypass

Section	Year
East Wait Avenue to South Main Street	Late 2004
South Main Street to US 1 (Capital Boulevard)	2008
US 1 (Capital Boulevard) to Durham Road	2012

Modeling and Forecasts

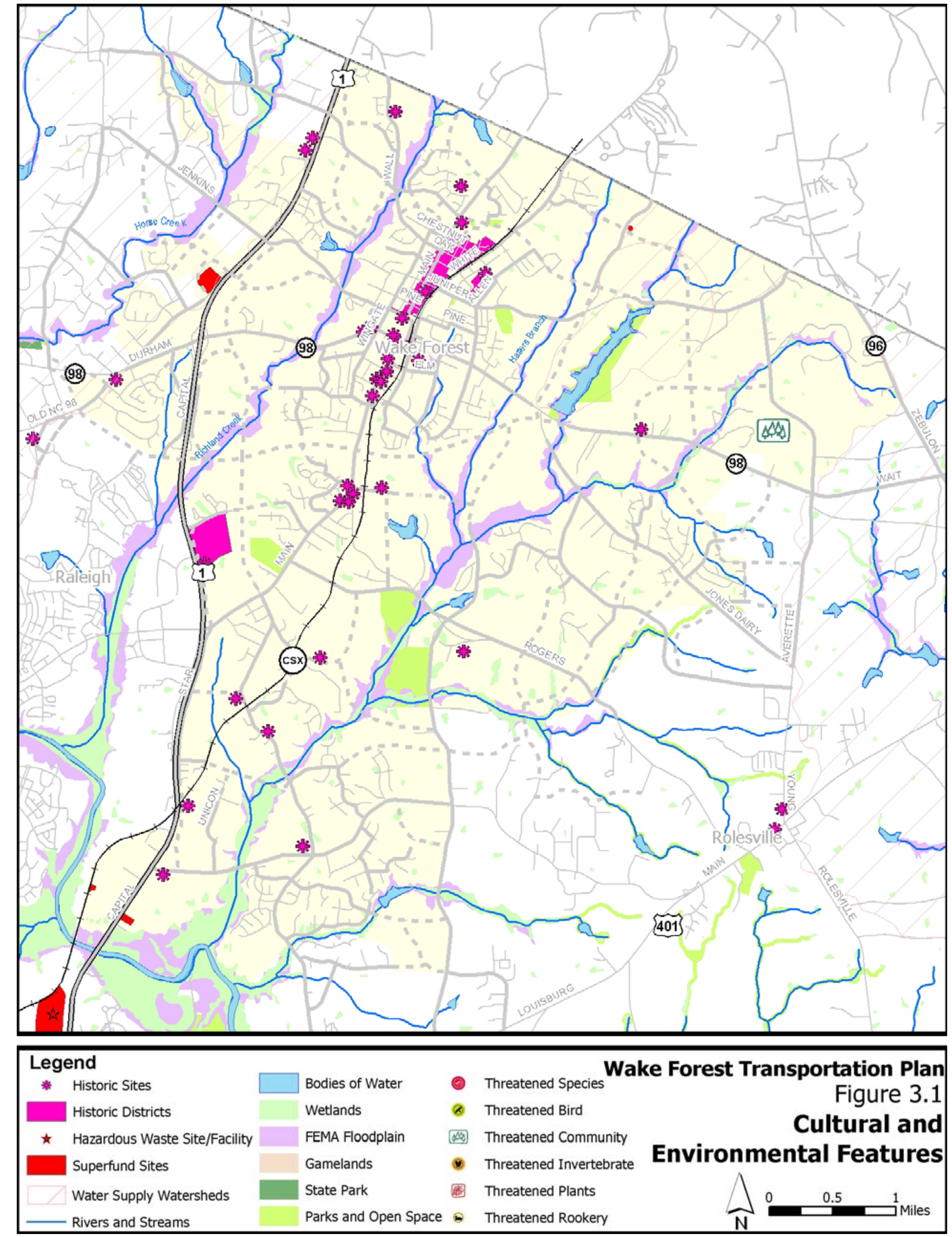
Travel demand on all major and minor thoroughfares serving Wake Forest have been projected for the year 2025. Recommendations in the transportation plan will be influenced by these 2025 forecasts. Future traffic growth assumes that the town, county, and region will continue to grow and increase in population and as well as employment opportunities.

Currently, Wake Forest has a population of approximately 15,000 people. Forecasts in population (from socioeconomic data in the Triangle Regional Model) indicate that the town may grow to a population of more than 47,000 people by 2025. Similarly, employment (number of jobs in Wake Forest) is forecast to increase from the current 6,500 jobs to more than 21,000 jobs by 2025. The charts on this page illustrate these growth trends.

The Triangle Regional Model is the primary tool for forecasting and evaluating future travel demand in the Triangle. The model relies on population, employment, and transportation system forecasts in three horizon years—2005, 2015, and 2025—to forecast future travel demand. While the model is not perfect, it is the accepted regional tool for projecting future travel demand.

Natural Environment

Wake Forest is a growing community. As it grows, open space and natural resources are impacted. Despite these impacts, some natural features must be maintained to satisfy state and federal environmental policies and agencies. **Figure 3.1** illustrates important environmental features in Wake Forest. The map shows watersheds, wetlands, FEMA floodplains, bodies of water, historic sites, historic districts, and superfund sites.



Throughout the *Wake Forest Transportation Plan* development process, natural features were considered. The location of these features was important to determining where new roads could be constructed and where existing roads could be widened and improved.

ALTERNATIVES

The future can be influenced by strategic land use and transportation choices that are made today. To better understand the effects that new and widened roadways will have on traffic and mobility in Wake Forest, five alternatives for 2025 were studied and are described as:

A. Existing plus committed (funds) transportation network
B. Adopted *CAMPO Thoroughfare Plan*
C. Currently adopted *Wake Forest Thoroughfare Plan*
D. Currently adopted *Wake Forest Thoroughfare Plan* with NC 98 bypass extending to US 1A
E. Currently adopted *Wake Forest Thoroughfare Plan* without the NC 98 bypass

Table 3.1 shows roadway improvements modeled in each alternative.

Table 3.1—Modeled Alternatives

Roadway Project/Alternative	A	B	C	D	E
US 1 as a Major Thoroughfare	■				
US 1 as a Freeway from I-540 to US 1A South Main Street					■
US 1 as a Freeway from I-540 to NC 98 Bypass			■	■	
US 1 as a Freeway from I-540 to the Wake County Line		■			
NC 98 Bypass from NC 98 at Thompson Mill Road to Wait Avenue	■	■	■		
NC 98 Bypass from NC 98 at East Wait Avenue to US 1A/South Main Street				■	
No NC 98 Bypass					■
New Falls of the Neuse Road	■	■	■	■	■
Ligon Mill Road Extension from South Main Street to NC 98			■	■	■
Harris Road Extension from North Main Street to Wait Avenue		■	■	■	■
Heritage Lake Road (and Extension) from Rogers Road to NC 98 Bypass			■	■	
Heritage Lake Road (and Extension) from Rogers Road to Franklin Street Extension					■
Franklin Street Extension from Holding Street to Rogers Road		■	■	■	■
Complete Outer Loop	■	■	■	■	■

Travel demand forecasts for each alternative were developed using the Triangle Regional Model. In general, forecasted travel demand indicates that US 1 and NC 98 will continue to be significant travel routes for Wake Forest as well as for regional traffic. Further summaries of individual alternatives and results are summarized in the following.

Alternative A

This alternative represents the future transportation network of roadways and the TTA rail system, constrained by the list of projects already committed in the 7-year State Transportation Improvement Program (TIP). Major future roadway projects modeled in this alternative include the complete NC 98 bypass, the complete Outer Loop (I-540), and the realignment and extension of Falls of the Neuse Road.

Analysis of this alternative indicated that the NC 98 bypass will serve the intended purpose of diverting through traffic away from downtown Wake Forest, which will relieve existing sections of NC 98 that currently use South Avenue, Front Street, East Roosevelt Street, and East Wait Avenue. In addition, the bypass will help relieve congestion on South Main Street (US 1A) by providing an additional east/west connection from US 1 to Wake Forest's downtown and to areas east of the town. In this alternative, US 1 will continue to be an important north/south route and experience congestion. Conversion of US 1 to a full freeway facility is considered in Alternative B.

Alternative B

The current *CAMPO Thoroughfare Plan* was adopted in April 2002. Before this plan, the latest adopted plan was dated 1997 and revised as recently as May 1999. Projects modeled in this alternative (not modeled in Alternative A) include the following:

- US 1 as a freeway from the Outer Loop to the Wake County/Franklin County line
- Harris Road extension from North Main Street to East Wait Avenue
- Franklin Street extension from Holding Street to Rogers Road

Although the network modeled in this alternative includes projects not included in Alternative A, the results are similar. US 1 is the primary north/south corridor and NC 98 bypass is the primary east/west corridor. As expected, with US 1 upgraded to a freeway, traffic growth (and attractiveness of the travel route) is increased. This is expected to reduce the pressure of regional traffic on other nearby north/south corridors, but at the same time add traffic to east/west corridors that have interchanges with US 1. In some cases east/west corridors will need to be widened in the vicinity of interchanges as a result of the increased travel demand.

Alternative C

Much like the adopted *CAMPO Thoroughfare Plan*, the adopted *Wake Forest Thoroughfare Plan* assumes that the NC 98 bypass extends from NC 98 (Durham Road) to East Wait Avenue, east of the downtown in Wake Forest. The most notable difference between this alternative and Alternative B is the extent to which US 1 will be improved to a freeway. In the *Wake Forest Thoroughfare Plan*, US 1 is shown as a freeway from the Outer Loop to present-day NC 98 (Durham Road) whereas in the *CAMPO Thoroughfare Plan*, the freeway extends further northward to the Wake/Franklin County line.

Roadway projects modeled in this alternative (not modeled in previously discussed alternatives) include:

- Ligon Mill Road extension from South Main Street (US 1A) to NC 98 (Durham Road)
- Heritage Lake Road (and extension) from Rogers Road to NC 98 bypass

Changing the status of US 1 to a freeway does alter travel patterns in the vicinity of Wake Forest, but not dramatically. While US 1 as a freeway will attract additional trips to east/west corridors connecting to interchanges, forecasts indicate that this travel demand can be accommodated with minor road widening in the vicinity of interchanges. Regardless of whether the corridor is constructed as a freeway or remains a principal arterial, it will continue to be the primary north/south route in the study area.

Alternatives D and E

These two alternatives study the effects of the NC 98 bypass in two states. Alternative D studies the effects of the bypass if it is constructed only to US 1A and Alternative E studies the effect of not constructing the bypass. Results from the model indicated that the partial bypass is much less effective in diverting east/west through traffic away from Wake Forest's downtown streets.

Not constructing the bypass has the expected effect of continued cut-through traffic in the downtown area and increased traffic levels on downtown streets that include North Avenue, South Avenue, Front Street, East Roosevelt Avenue, East Wait Avenue, and South Main Street (US 1A). **Table 3.2** shows the contrast in future forecasted traffic volumes with, with the partial, and without the NC 98 bypass.

Table 3.2—2025 Traffic Volume Comparison for NC 98 Bypass Scenarios

Street	Full Bypass	Bypass to US 1	No Bypass
Durham Rd. (Existing)	1,500	4,400	5,500
South Avenue	1,200	5,400	6,700
Front Street	3,600	4,800	6,200
East Wait Avenue	1,700	4,300	9,700
South Main Street (US 1 to the bypass)	30,500	42,000	24,000

Seminary Area Traffic Circulation Alternatives

A topic of discussion from the beginning of the development of the *Wake Forest Transportation Plan* has been that of handling traffic on the streets surrounding and approaching the Southeastern Baptist Theological Seminary. Specifically, the traffic flow on the Seminary loop, which is made up of Wingate Street, South Avenue, Front Street, and North Avenue.

During peak hours and peak travel periods of the day, traffic congestion occurs east/west on NC 98 (South Avenue, Front Street, East Roosevelt Avenue, and East Wait Avenue). A number of context sensitive, traffic circulation alternatives were developed to explore the potential for operational improvements without widening roadways or adding traffic signals to these streets. Alternatives include:

- **Alternative 1 (Figure 3.2)** is a one-way (counterclockwise) loop. Wingate Street is closed to through traffic and a new through street is constructed west of the existing intersection of Wingate Street/NC 98 that connects to Rock Springs Street on the north and a realigned section of Wingate Street on the south.

- **Alternative 2 (Figure 3.3)** is a two-way loop with roundabouts at the following intersections:
  - Durham Road (NC 98)/Wingate Street
  - South Avenue (NC 98)/South Main Street (US 1A)
  - Front Street (NC 98)/East Roosevelt Avenue (NC 98)
  - East Roosevelt Avenue (NC 98)/White Street
  - North Avenue/North Main Street
  - North Avenue/Stadium Drive/Wingate Street

Figure 3.2
Circulation Alternative 1

Figure 3.3
Circulation Alternative 2

- **Alternative 3 (Figure 3.4)** is a one-way (counterclockwise) loop with directional islands at North Main Street/North Avenue and Front Street/East Roosevelt Avenue as well as roundabouts at the following intersections:
  - Durham Road (NC 98)/Wingate Street
  - East Roosevelt Avenue (NC 98)/White Street
  - North Avenue/Stadium Drive/Wingate Street

The modern roundabouts included in the alternatives facilitate all turning movements while maintaining the desired traffic flow pattern (one-way or two-way). In general, these roundabouts have the ability to improve traffic flow, reduce the frequency and severity of accidents, and improve the aesthetics of locations where they have replaced traditional intersections and traffic control devices.

Recommended Thoroughfare Plan

INTRODUCTION

The recommended thoroughfare plan for Wake Forest, shown in **Figure 4.1**, represents an integrated planning process that considers the adopted thoroughfare plan, existing and planned land uses, existing and planned development, environmental constraints, and projected future travel demand. It includes recommendations for major and minor thoroughfares and collector streets throughout Wake Forest's planning jurisdiction.

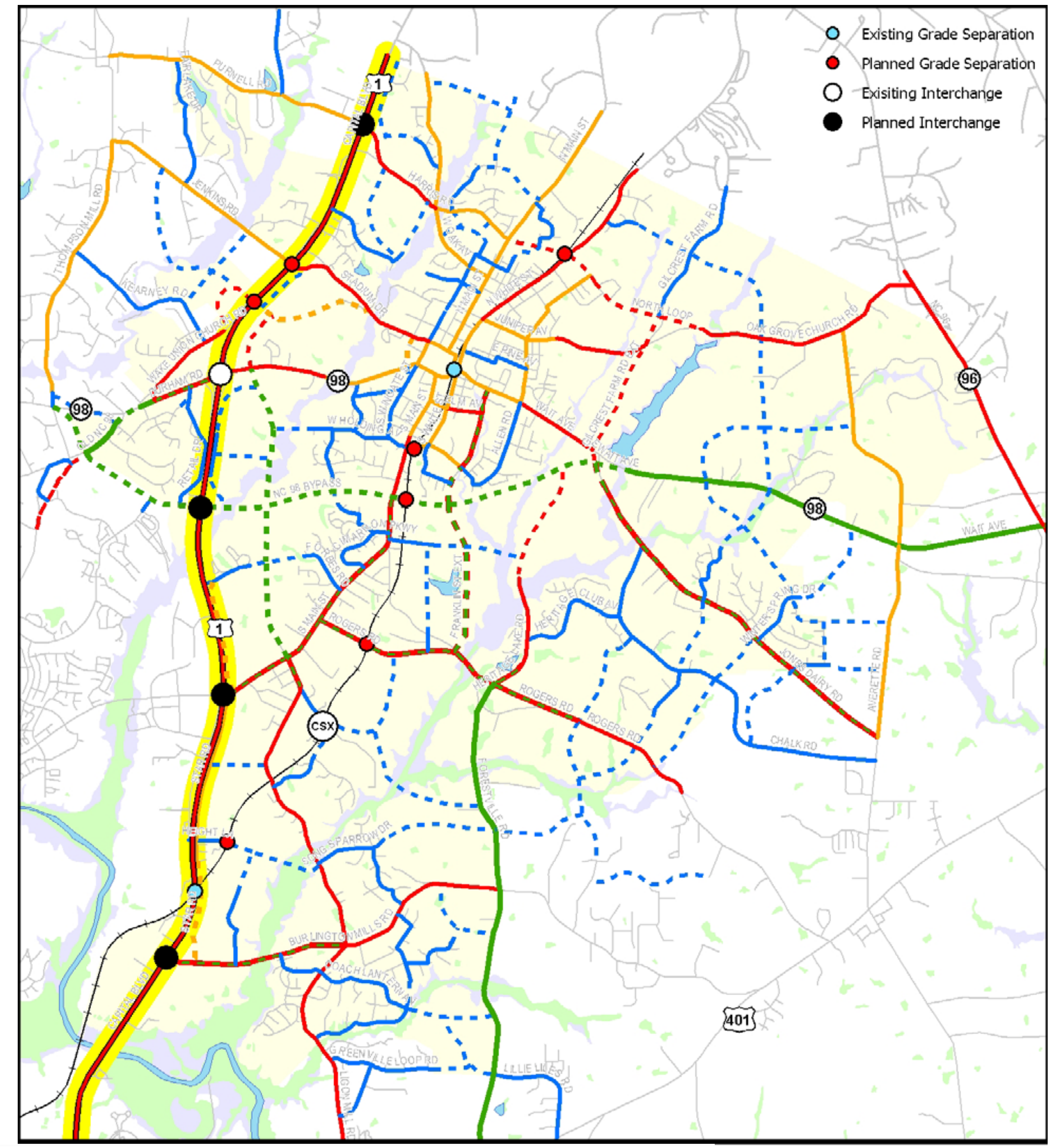
The plan shows numerous new roadway facilities. With respect to these, it is important to note that they do not represent specific roadway alignments, but rather a series of connections. As Wake Forest continues to grow and new roads are needed, these alignments will need to be studied in greater detail and consideration given to shifting the roadway alignment as needed to minimize impacts and fit into development plans.

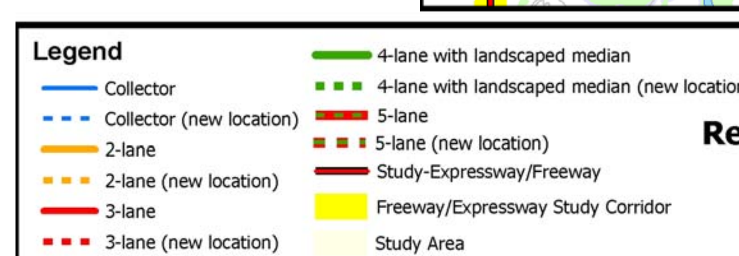
THOROUGHFARE PLAN

Figures 4.1 and **4.2** depict the recommended thoroughfare plan for Wake Forest. **Figure 4.1** illustrates the plan by roadway cross section while **Figure 4.2** illustrates the plan in terms of street classification. Currently, the majority of Wake Forest's streets have two lanes and are relatively uncongested. Some of these streets have exclusive left-and right-turn lanes. In the future, as development continues and Wake Forest grows within and away from its historic downtown, traffic will increase. In some cases, existing street cross sections will be adequate. In others, streets may need to be widened, and for others yet, increases in traffic will necessitate the construction of a new corridor.

A discussion of key corridors is presented in the following section and also in **Appendix A**, which contains the following information:

- Recommended roadway cross section
- Snapshot picture of the existing roadway
- Existing and future roadway capacity
- Existing and recommended right-of-way width
- Existing and forecasted traffic volume (ADT)





Wake Forest Transportation Plan
Figure 4.1
Recommended Thoroughfare Plan

Kimley-Horn and Associates, Inc.

Averette Road is a two-lane rural road with narrow travel lanes and a posted speed limit of 45 mph. Development along this corridor is anticipated to be suburban/rural in character, mostly in the form of large lot single-family homes with densities of between one and two dwelling units per acre. With these types of densities anticipated, the existing cross section with additional left-turn lanes will be adequate to serve future travel demand. The following is recommended:

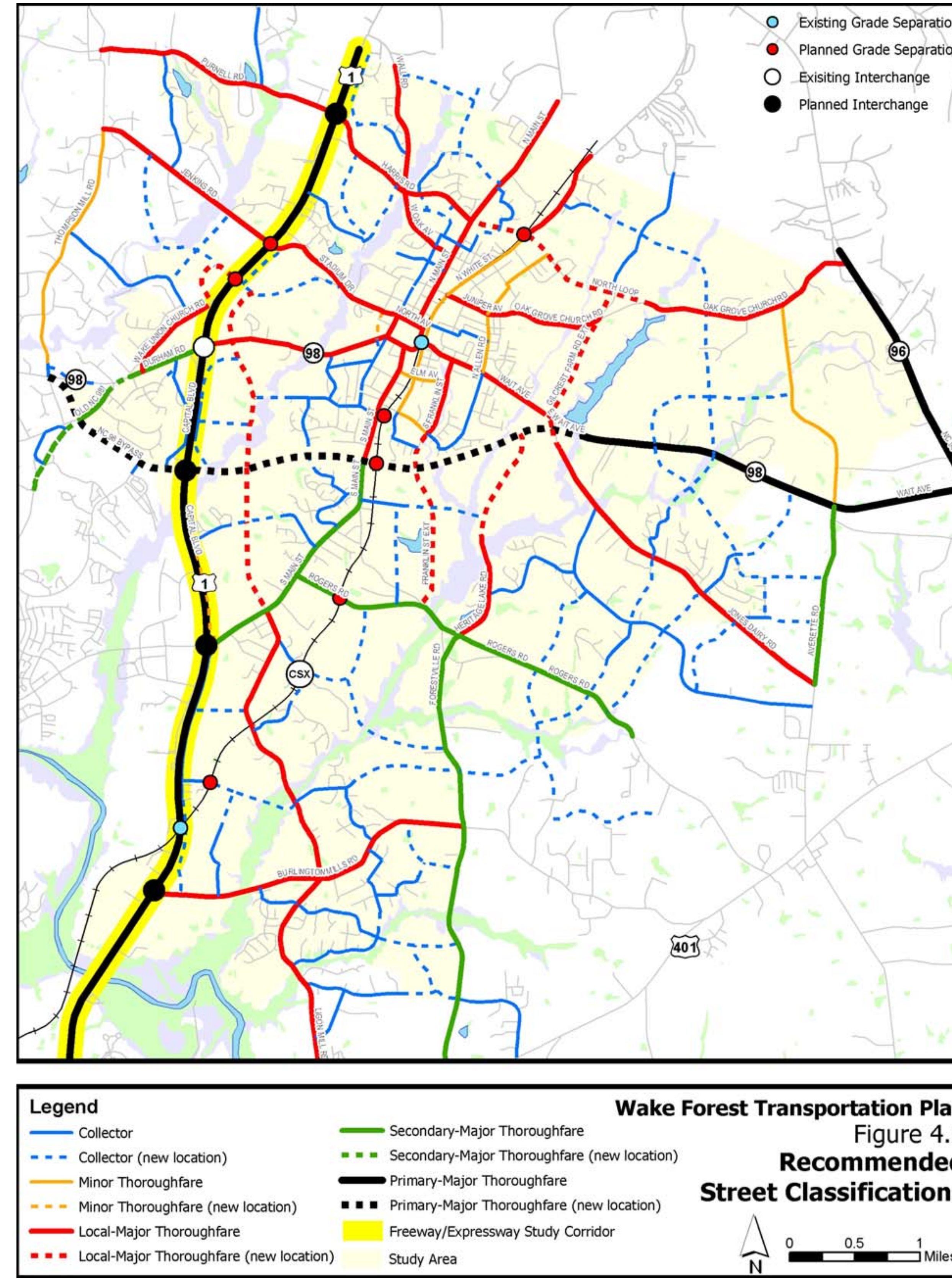
- Provide left-turn lanes/bays at intersections, new neighborhood entrances, and major driveways

Burlington Mills Road is currently a two-lane rural road with a mixture of signalized and unsignalized intersections. Land uses along the corridor are composed of mostly low-density, rural residential, and agricultural uses, although convenience retail has been developed near US 1. Traffic growth in this corridor will be the result of a number of factors. Growth/development of a community oriented activity center at US 1, the development of existing open spaces along the corridor into residences, and the potential for Burlington Mills Road to have an interchange at US 1—if it is converted to a freeway—will all contribute new traffic to this corridor. To accommodate these increases, the following is recommended:

- From US 1 to Forestville Road, acquire 90 feet of right-of-way
- Widen the existing roadway to a five-lane cross section from US 1 to Ligon Mill Road
- Widen the existing cross section to a 45-foot roadway from Ligon Mill Road to Forestville Road
- Provide sidewalks on both sides of the roadway from US 1 to Forestville Road

Capital Boulevard (US 1) through Wake Forest is currently a four-lane divided highway with one interchange, one railroad grade separation, and numerous signalized and unsignalized intersections. Individual property access varies throughout the corridor. In some sections, individual driveways have access to US 1, in others, driveways are combined or have access only to a frontage road. In general, median crossover points along the corridor are limited to signalized intersections and unsignalized public streets.

Currently, congestion on US 1 nearly reaches Wake Forest in the AM peak hour, which makes it difficult for residents to travel south efficiently. In the evening, US 1 is congested from Durant Road through Burlington Mills Road. In addition, traffic often moves slowly through signalized intersection at New Falls of the Neuse Road/US 1A/South Main Street.



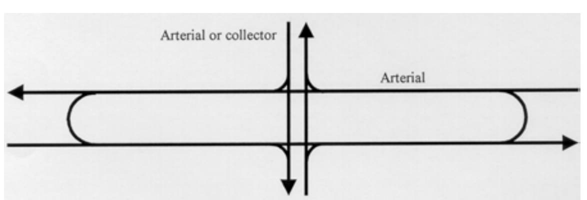
Wake Forest Transportation Plan
Figure 4.2
Recommended Street Classifications

In the future—the US 1 corridor will have continued and in some cases higher—importance in moving people and goods throughout the region as well as to areas north of Wake County (to I-85). The result of this continued importance will be a significant traffic growth from a number of sources including population and employment growth north of the Triangle region as well as growth within the region. Increases in traffic have the potential to create serious capacity problems throughout the corridor.

The adopted *CAMPO Thoroughfare Plan* (2002) recommends that US 1 be studied in greater detail for the possible conversion to a freeway. Wake Forest supports this idea; however, the town also understands that this conversion poses significant challenges to implementation including:

- High cost
- Access restrictions
- Environmental impacts
- Public opinion

In support of CAMPO's recommendation, interim and long-term recommendations are proposed. Interim measures are intended to control and consolidate existing access in preparaton for the long-term recommedation of US 1's conversion to a full freeway facility.



Median U-Turn Diagram

Interim (2002-2025)

- Support local efforts to commission a study working with CAMPO and the City of Raleigh
- As development continues along US 1, require right-of-way along property frontages to be dedicated and/or new frontage roads to be constructed and connected to existing frontage roads
- As signalized intersections along the corridor become increasingly congested and add delay to US 1, study the potential for the removal of left-turn movements from the side streets through the use of median U-turn and other innovative arterial treatments
- At unsignalized intersections, restrict full-movement median openings in favor of directional median openings at a minimum of ½ mile spacing
- Develop alternative access plans that support the eventual closure of all driveways accessing US 1
- Limit new driveway access to right-in right-out only with exclusive right-turn lanes and condition the approval of these access with eventual removal when US 1 is converted to a freeway

Long-Term (post 2025)

- Eliminate all at-grade median crossovers (includes intersections and median openings)
- Construct/provide interchanges along US 1 at the following locations: Burlington Mills Road, New Falls of the Neuse Road/South Main Street, NC 98 bypass, Durham Road, and Purnell Road/Harris Road
- Construct grade separations (no ramps) at the following locations: Stadium Drive/Jenkins Road, and Wake Union Church Road
- Complete any discontinuous service roads along the east side of US 1 from Burlington Mills Road to NC 98

Durham Road (NC 98) takes on several different characters in Wake Forest. West of Wake Forest it is a rural highway with wide shoulders and little development. As Durham Road enters Wake Forest on the west, the two-lane roadway transitions to four and five lanes. In the same section, residential development gives way to strip commercial development in the near the US 1/NC 98 interchange. A few hundred feet east of the interchange, Durham Road transitions to a two-lane road and is bordered by single family homes. Across Richland Creek, Durham Road takes on another character. In this section it has a sidewalk along one side and older and historic homes along both sides.

Traffic will increase on Durham Road west of US 1. Commercial activity in this area coupled with the US 1 interchange will result in increases in traffic on this section of roadway. To accommodate future travel demand the following are recommended:

- Install a closed loop signal system for the traffic signals in the vicinity of the US 1/NC 98 interchange
- Develop a streetscape plan for Durham Road from Wake Union Church Road to the US 1 interchange—construct sidewalks, a bikeway, and plant street trees throughout this section of roadway
- Provide a multi-use path along one-side of the corridor from the shopping center entrances west of US 1 to Tyler Run Drive
- Construct an appropriate gateway treatment east of the planned NC 98 Bypass
- Widen the existing cross section from Thompson Mill Road to Wake Union Church Road to four lanes with a landscaped median
- Widen the existing cross section from Wake Union Church Road to US 1 to five lanes

Elm Avenue runs along the south side of Wake Forest's commerical downtown area. West of the railroad tracks it has a funeral home on one side and several small businesses on the other. East of the railroad, Elm Avenue transitions to a four-lane commercial street and extends to Franklin Street. Miller Park, Town Hall, and commercial activity in Wake Forest's town center bring people and cars to Elm Street. Sidewalks along both sides of the street, in addition to wide travel lanes, provide opportunities for pedestrians and cyclists as well as vehicles to travel along this street. Future

An Example of an Improved At-Grade Railroad Crossing

forecasts indicate that the existing cross section will be adequate to accommodate travel demand; however, minor enhancements are recommended to enhance the pedestrian environment:

- Modify approach grades to reduce the hump created by the existing railroad tracks
- Install an improved railroad crossing
- Upgrade the railroad crossing with four-quadrant automated crossing gates
- Improve the pedestrian crossing across the railroad corridor
- Develop an attractive streetscape for Elm Street from the railroad corridor to Franklin Street
- Consider ways to provide alternate access to nearby properties in order to build an undercrossing for Elm Street under for the railroad tracks

Forestville Road/Heritage Lake Road is a two-lane corridor with posted speed limits of between 45 and 50 mph. At the northern end of the corridor, Heritage Lake Road provides direct access to the Heritage Wake Forest Development. This large development includes schools, parks, residences, a golf course, and commercial development. It is anticipated to be built out before 2025. Increases in traffic from this development as well as from other growth along the corridor will necessitate roadway improvements. Recommendations are the following:

- Widen the existing cross section to a four-lane median divided roadway from US 401 (Louisburg Road) to Rogers Road
- Widen Heritage Lake Road to five lanes from Rogers Road to 1000 feet north of Rogers Road
- Extend Heritage Lake Road from its current terminus to the NC 98 bypass as a three-lane roadway with wide outside lanes (14-foot) and sidewalks on both sides
- Develop an access management plan to identify the location of future median openings (typically spaced 1,500 feet apart) and require new developments to locate major subdivision/development driveways at these locations. This will minimize controversy when Forestville Road is ultimately widened to a four-lane median divided cross section.

South Franklin Street runs between East Wait Avenue and Holding Avenue, but is planned to be extended to the NC 98 bypass and then to Rogers Road. This planned connection will increase mobility into and out of downtown Wake Forest. With the near proximity of the Heritage development, the potential for a Transit Oriented Development (TOD), and continued growth in the town's downtown, Franklin Street will inevitibly see increases in traffic. To accomodate increases in traffic, recommendations are the following:

- Extend South Franklin Street to Rogers Road as a five-lane cross section with wide outside lanes (14 feet) and sidewalks on both sides
- Consider alternatives to signalizing the intersection at Rogers Road

Holding Avenue is currently two lanes with sidewalks on both sides and an at-grade crossing with the railroad. Today, West Holding Avenue and East Holding Avenue do not align with one another at South Main Street. West Holding Avenue is a very wide collector street running through the Tyler Run subdivision and East Holding Avenue is a narrower street that runs along the southern edge of downtown Wake Forest. With the potential for High Speed Rail Service in the future it is likely that the at-grade crossing with East Holdign Avenue will be closed. To provide for continued mobility across the railroad corridor it is recommended to pursue a grade separated crossing of the railroad. Currently, West Holding Avenue nearly aligns with a small residential street that has an elevation significantly below that of the railroad, providing the opportunity to pursue a grade separation below the railroad.

Although the Southeast High Speed Railroad initiative is planned to pass through Wake Forest, it will be a number of years before it begins operations. To improve safety and operations along Holding Avenue, the following interim improvements are recommended:

- Install an improved (rubber, concrete, or steel, reinforced) railroad crossing on East Holding Avenue
- Upgrade the existing railroad crossing equipment with four-quadrant automated crossing arms
- Install a traffic signal at East Holding Avenue

Jones Dairy Road is currently a two-lane residential road between East Wait Avenue and Averette Road. Currently, land uses along this corridor are primarily large lot residential and agricultural uses. Development along this corridor is anticipated to continue, consisting mostly of large lot residences and subdivisions. When the NC 98 bypass is completed, modifications will need to be made to the western end of Jones Dairy Road as shown in **Figure 4.1**. The impacts of new development coupled with regional growth will increase traffic volumes in this corridor and will require that improvements be made. Recommendations are the following:

- Require new development to construct left-turn lanes at major access points, new streets, and driveways
- Reserve 90 feet of right-of-way for a future five-lane cross section with wide outside lanes (14 feet) and sidewalks on both sides

Juniper Avenue/Oak Grove Church Road is a two-lane corridor that extends from White Street to NC 96. Near White Street, Juniper Avenue is bordered by established neighborhoods with homes on smaller lots as well as the Ailey Young Park near Jubilee Court. East of Jubilee Court, there is a transition from established residential uses to rural residential and agricultural uses. Increases in traffic along the corridor are anticipated and will primarily be the result of new residential development. The following are recommended:

- Provide left-turn lanes/bays at intersections and major driveways
- Close gaps in the sidewalk on one side from White Street to Allen Road
- Enhance the street environment with improved sidewalks, curb and gutter, and street trees between White Street and Jubilee Court
- Build sidewalks and/or a multi-use path from Allen Road to the planned North Loop
- On Oak Grove Church Road, widen the existing cross section to three lanes if few driveways are anticipated, otherwise widen to five lanes

Ligon Mill Road is currently a two-lane corridor that runs between South Main Street (US 1A) and Louisburg Road (US 401). An extension of this corridor is proposed and would continue the road northward from South Main Street to Durham Road (NC 98). Development in this corridor is expected to be primarily residential; however, neighborhood oriented commercial development is also likely. As traffic congestion increases on Capital Boulevard, Ligon Mill Road can expect to see commuters looking for alternate routes using Ligon Mill Road to make trips between Wake Forest and Raleigh. Traffic increases related to this as well as area growth will result in the need for future corridor improvements. The following are recommended:

- Extend Ligon Mill Road from Durham Road (NC 98) to South Main Street as a four-lane median divided cross section with wide outside lanes (14 feet) and sidewalks on both sides
- Widen the existing roadway to five lanes with wide outside lanes (14 feet) and sidewalks on both sides from South Main Street to Seawell Road
- Widen the existing roadway to three lanes with wide outside lanes (14 feet) and sidewalks on both sides from Seawell Road to US 401
- Widen the existing cross section to four lanes (curb and gutter) with a landscaped median and wide outside lanes (14 feet) from Burlington Mills Road to Louisburg Road (US 401)

Future North Loop (Gilcrest Farm Road Extension) is a planned three-lane corridor (90 feet of right-of-way) that will run between North Main Street and East Wait Avenue. The majority of this planned facility will be constructed as a part of planned development. The North Loop will greatly enhance connectivity in northeastern Wake Forest by providing connectivity between East Wait Avenue and North Main Street. With significant residential development planned along this corridor in addition to growth througout northeastern Wake Forest, this corridor will carry significant volumes of traffic. To accommodate this demand the following is recommended:

- Construct a three-lane (shoulder) cross section on new location from North Main Street to East Wait Avenue with 14-foot outside lanes and sidewalks on both sides of the street

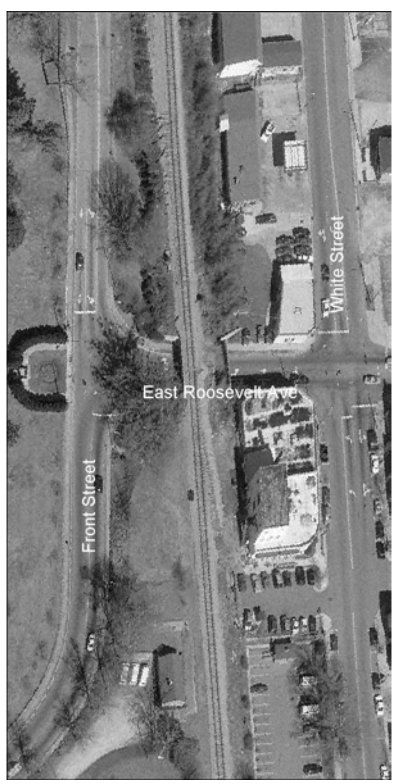
North Main Street (US 1A) serves as one of Wake Forest's northern gateway corridors. The street's character changes dramatically from north to south. North of Cedar Street, Main Street is mostly a rolling two-lane rural road bordered by homes on large lots and land under cultivation. South of Cedar Street, North Main Street is a two-lane street with a beautifully landscaped median, sidewalks, and historic homes fronting the street. To maintain the inviting nature of this corridor while making it more bicycle and pedestrian friendly, the following are recommended:

- Retain the existing cross section from Cedar Street to North Avenue
- Construct a matching cross section (similar to the existing from North Avenue to from Cedar Street) from Cedar Street to Oak Avenue
- North of Oak Avenue, widen the existing cross section to provide wide lanes (15 feet) and construct exclusive left-turn lanes at intersections with all public streets and major subdivision entrances

Oak Avenue/Wall Road is currently a two-lane corridor with a variable cross section. From US 1 to Remington Woods Drive it has two ten-foot travel lanes and is bordered by rural residential and agricultural uses. From Remington Woods Drive to Wingate Street, the residential density is higher and the cross section is 41 feet wide with two travel lanes (one in each direction). From Wingate Street to North Main Street the residential density is similar, but the cross section narrows to two 10-foot lanes without sidewalks. These sudden changes disrupt the visual flow of the corridor, especially since the extra width in the one section does not seem to have a purpose. With Harris Road (to the north of Oak Avenue) carrying the majority of through traffic, Oak Avenue is primarily a route for local traffic. The following improvements are recommended:

- From US 1 to Remington Woods Drive widen the existing cross section to provide two 15-foot travel lanes and exclusive left-turn lanes at major subdivision driveways and intersections with public streets
- From Wingate Street to North Main Street widen the existing two-lane cross section to provide two 15-foot travel lanes (curb and gutter), a 5-foot verge, and 5-foot sidewalks on both sides of the street
- Construct sidewalks on both sides of the street from Harris Road to Remington Woods Drive

Three Lane Roadway with Median Street Trees



Existing Narrow Railroad Undercrossing on East Roosevelt Avenue

Purnell Road/Harris Road is a two lane undivided corridor that extends from Bud Smith Road to North Main Street. Large lot subdivisions and agricultural uses make up the majority of land uses along this corridor. There is the potential for a park site to be developed along Harris Road (west of Oak Avenue) as well as the potential for more new homes and businesses throughout the corridor. An extension of Harris Road is planned to connect the existing eastern end at North Main Street with North White Street. This connection would potentially involve the construction of a grade separation with the existing railroad. With new connections planned, the potential for new development, and the existing connection to US 1, this corridor is likely to have increases in traffic. To accommodate these increases, the following are recommended:

- Acquire 90 feet of right-of-way from US 1 to Oak Avenue and on new sections of Harris Road
- Widen Purnell Road/Harris Road to three lanes (shoulder section) with wide outside lanes and sidewalks on both sides from Oak Avenue to US 1

Rogers Road has been widened to a five-lane cross section throughout the Heritage development from South Main Street to Forestville Road. At the railroad crossing near South Main Street, the roadway was required to be narrowed to a two-lane crossing, effectively limiting the value of the otherwise provided five-lane cross section. East of Forestville Road, land uses are mostly residential and agricultural. West of Forestville Road is the planned Heritage development that includes homes, schools, and commercial uses. Increases in traffic are expected from areawide development and regional growth. To accommodate projected traffic, the following are recommended:

- Grade separate Rogers Road at the CSX railroad
- Widen Rogers Road to five lanes from Forestville Road to the eastern edge of the property for the Heritage development
- Widen Rogers Road to three lanes from the eastern property line of the Heritage development to Wellspring Farms Road
- Provide a 10-foot off-street multi-use path from South Main Street to Louisburg Road (US 401)

Roosevelt Avenue/Wait Avenue (NC 98) is a two-lane undivided corridor that runs from the historic downtown of Wake Forest eastward into rural areas of Wake County. This corridor is the route NC 98 takes through Wake Forest, resulting in high traffic volumes, high volumes of trucks, and frequent traffic congestion during the AM and PM peak hours. At the western end of the corridor in downtown Wake Forest, a narrow railroad bridge restricts the roadway from being adequately improved. During peak hours, queues form on South Avenue, Front Street, East Roosevelt Avenue, and White Street. Some sections of the corridor have left-turn lanes, while others do not. East of Allen Road, East Wait Avenue transitions into a rural two-lane undivided highway.

Following completion of the NC 98 bypass, already under construction and funded in the current TIP, it is estimated that over half of the existing traffic currently using Roosevelt Avenue and East Wait Avenue may shift to the bypass. With the focus of Roosevelt Avenue/Wait Avenue from Front Street to the NC 98 bypass changing to a local purpose, the following are recommended:

- Provide left turn lanes at intersections and driveways throughout the corridor
- Repair, improve, and construct new (where needed) sidewalks
- Construct a gateway treatment west of the NC 98 bypass (near Jones Dairy Road)
- Develop a streetscape plan for East Wait Avenue/Roosevelt Avenue from the NC 98 bypass to Front Street

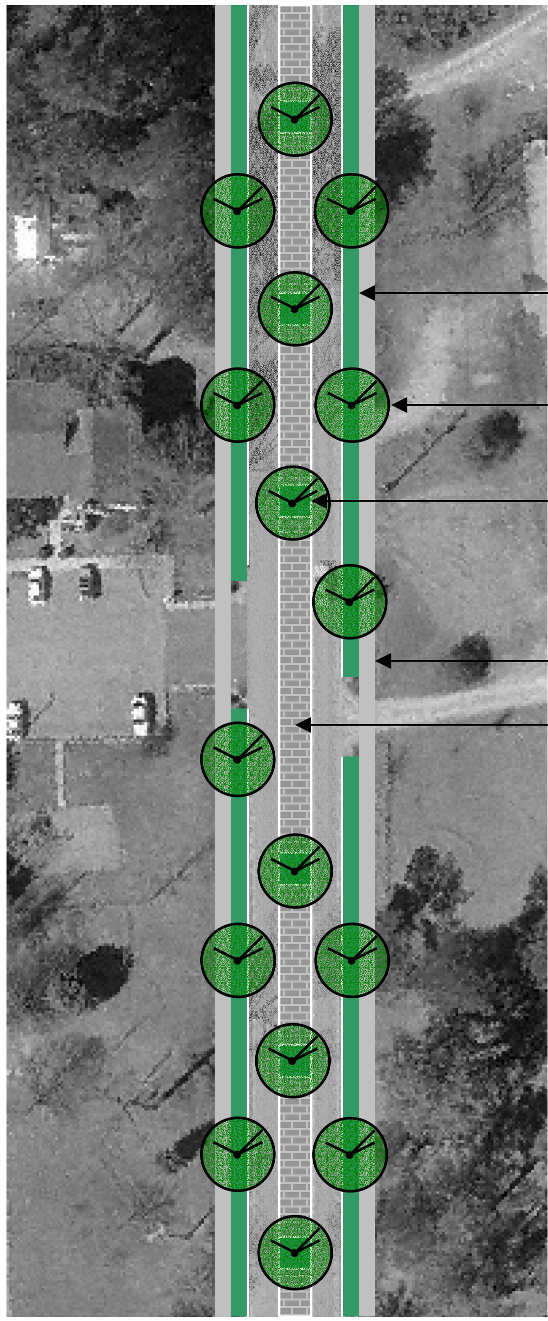
East of the NC 98 bypass, where the focus of traffic will be more regionally oriented, the following are recommended:

- Widen East Wait Avenue to four lanes with a landscaped median and wide outside lanes (14 feet) from the NC 98 bypass to NC 96

South Main Street (US 1A) has numerous cross sections throughout its length. Near US 1 some sections are two lanes undivided, some are five lanes, and still others are three lanes. Between Rogers Road and Holding Avenue the cross section is primarily three lanes with some variations where development has not yet occurred. North of Holding Avenue, the cross section is two lanes with on-street parking, sidewalks on both sides of the street, and a canopy of trees. South Main Street is a primary route between Capital Boulevard (US 1) and downtown Wake Forest. Much like the NC 98 corridor, South Main Street experiences periods of traffic congestion, and high truck volumes.

The NC 98 bypass will bring great relief to some sections of South Main Street, while in others it will create an increase in travel demand. Traffic can be expected to lessen on sections of South Main Street north of the NC 98 bypass, while on sections south of the bypass, traffic will increase. To accommodate shifts and in some cases growth in travel demand along this corridor, the following are recommended:

- Retain the existing cross section and street character from South Avenue to Holding Avenue



Three-Lane Street Concept for Stadium Drive and Sections of South Main Street

- Widen/improve the existing cross section to three lanes (interspersed with median street trees, see picture on previous page) with sidewalks on both sides from Holding Avenue to the NC 98 bypass
- From the NC 98 bypass to US 1, widen the existing cross section to five lanes with wide outside lanes (14 feet)
- Construct a ten-foot wide multi-use path on one side and a sidewalk on the other side from Holding Avenue to Capital Boulevard (US 1)
- Conduct signal warrant analyses to determine the need for traffic signals on South Main Street at Ligon Mill Road and Holding Avenue
- Study the feasibility of revising timing/phasing at New Falls of the Neuse Road/South Main Street/US 1 (Capital Boulevard) to give more green time to traffic movements on US 1 southbound and South Main Street westbound)

Stadium Drive/Jenkins Road is a two-lane undivided corridor from Thompson Mill Road to Rock Springs Road. Traveling from west to east, the land uses transition from large lot residential to smaller lot single family homes. At the high school, Stadium Drive transitions to a four-lane undivided cross section that extends to Wingate Street. With the high school, numerous residences, and opportunities to connect to downtown Wake Forest, the corridor has the potential to attract pedestrians and cyclists. Continued growth in and around Wake Forest will cause traffic to increase in this corridor in the future. To accommodate future traffic volumes as well as multimodal activities, the following are recommended:

- Widen the existing two-lane cross section to have 15-foot lanes from Thompson Mill Road to Capital Boulevard (US 1)
- Provide left-turn lanes/bays at intersections and major driveways from Thompson Mill Road to Capital Boulevard
- Develop a streetscape plan for Stadium Drive between US 1 and Wingate Street
- Widen the existing cross section to three lanes (interspersed with median street trees) from Capital Boulevard to Rock Springs Street
- Provide a sidewalk along one side and a ten-foot multi-use path along the other from Capital Boulevard (US 1) to Wingate Street
- Improve or construct a new bridge that will accommodate vehicles, pedestrians, and cyclists over Richland Creek
- Monitor traffic and crash statistics to evaluate alternative striping and lane arrangements on the Stadium Drive/Jenkins Road approaches to US 1

Wake Union Church Road serves numerous businesses, single family homes, and subdivisions. This corridor has become a popular location for businesses and is in the process of becoming stripped out with commercial development. Currently this road provides an important fuction of providing access to businesses that do not have access to US 1. In the future, as development continues, this road will undoubtedly have increased traffic. Currently the northern end of Wake Union Church Road makes a sharp—nearly 90 degree—curve at US 1 (traffic signal). With the potential for US 1 to become a freeway and this current alignment issue that will in time affect roadway and intersection capacity, a new alignment should be developed for the northern end of Wake Union Church Road as shown on the recommended thoroughfare plan map. To accommodate future travel demand, the following are recommended:

- Realign the northern end of this corridor by moving the roadway west, behind the vacant business near US 1
- Reserve right-of-way for a future grade separation at US 1
- Acquire 90 feet of right-of-way throughout the corridor
- Widen the existing roadway to three lanes

White Street links residential neighborhoods to Wake Forest's historic downtown area. It is "Main Street" from East Roosevelt Avenue to Elm Avenue. North of downtown, White Street serves commuter traffic from Franklin County in addition to low-density commercial and residential uses in northern Wake Forest. The corridor is primarily two lanes, ranging from 21 feet wide on the north end to 42 feet wide in downtown. Parking and sidewalks are provided along both sides of the corridor from East Roosevelt Avenue to Elm Avenue. South of Elm Avenue sidewalks are planned, but have not yet been constructed. The CSX railroad runs parallel to White Street, from Holding Avenue to the Wake County line. This creates a number of issues with cross street connectivity from the west in addition to creating limitiations on what can be done to improve White Street. To accommodate future travel demand, improve the attractiveness of the corridor, and create walking and cycling opportunties, the following are recommended:

- Maintain the existing cross-section and streetscape from Elm Avenue to East Roosevelt Avenue
- Extend a compatible downtown-style streetscape with sidewalks from Elm Avenue to Holding Avenue
- Improve/widen (to 5 feet) existing sidewalks along the east side of White Street from Roosevelt Avenue to Juniper Avenue
- Provide a 10-foot multi-use path on the east side of White Street from Juniper Avenue to the Wake County line
- Provide left-turn lanes at major subdivision entrances and public streets between East Roosevelt Avenue and the Wake County line
- Identify potential pedestrian crossing points (over the railroad) to reduce the effect of the railroad as a physical barrier to the community
- Add curb and gutter throught improved sections of White Street

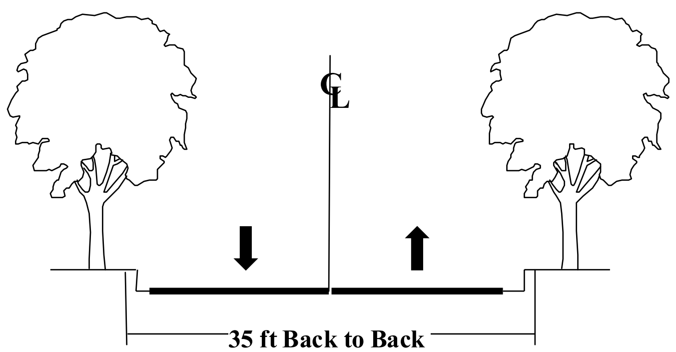
Wingate Street between Stadium Drive/North Avenue and South Avenue is an important downtown circulation street for Wake Forest. In the future

On-Street, Pocket Parking

this street will be relocated by the Seminary to accommodate development plans. At that time, Wingate Street will become an access drive for Seminary parking lots. The north terminus of the street will be relocated from Stadium Drive/North Avenue to Rock Springs Street. To tie the new (relocated) Wingate Street at the southern end will require a minor relocation of Wingate Street south of South Avenue. It is recommended that the new (relocated street) be constructed as a two-lane undivided cross section, incorporating on-street pocket parking. The new cross section should also provide left-turn lanes at Stadium Drive and South Avenue and sidewalks on both sides.

Zebulon Road (NC 96) is a two-lane rural road with a posted speed limit of 45 mph and 10-foot lanes. Current land uses along the corridor include low-density residential and agricultural uses. It is unlikely that development will intensify significantly along this corridor. With this understanding, the existing cross section with left-turn lanes at intersections will be adequate to serve future travel demand. The following are recommended:

- Widen the existing cross section to 36 feet to provide a safe and wider two lane cross section that incorporates left-turn lanes at intersections
- Implement an access control policy to manage residential driveways
- Provide left-turn lanes at intersections



Residential Collector Street

Collector Streets

The development of an effective collector street plan is essential to providing good mobility throughout Wake Forest. Although collectors primarily serve local access and circulation functions, a well-planned, interconnected network of streets also has the ability to alleviate some of the burden that local trips have on thoroughfares. Collector streets should provide good vehicular and non-vehicular connections between desired destinations such as homes, schools, parks, shopping, and offices without the use of a thoroughfare.

Misconceptions

Collector streets are not to be confused with local streets. Local streets often end in cul-de-sacs or form loops within neighborhoods. The primary purpose of local streets is to provide access to adjacent land use.

Collector streets are not planned or designed to serve as relievers, equivalent parallel routes, or other such designations that would encourage or promote cut-through traffic. They are not thoroughfares and are not intended to carry regional or other travelers over long distances at high speeds. However, as stated above, collector streets are intended to provide access and connectivity for short distance travel.

Issues

Understandably there are challenges and constraints to implementing an interconnected collector street system. The collector street network shown in the *Wake Forest Transportation Plan* is a starting point and is intended to serve as a framework of connections rather than a network of specific alignments. As Wake Forest continues to grow and construct new collector streets, specific roadway alignments will need to be studied in greater detail. Additionally, to ensure success, Wake Forest will need to involve businesses, residents, and other important stakeholders, educating and building consensus in the process of locating and designating new streets.

To provide for flexibility and compatibility in the town's future collector street system, it is recommended to require new collector streets to be constructed with either a 35-foot back-to-back cross section or a 41-foot back to back cross section. **Table 4.1** shows design details of new and existing retrofitted (where possible) collector streets.

Table 4.1—Collector Streets

Characteristic	Residential	Non-Residential (Service Roads)
Design Speed	25 mph	40 mph
Right of Way	60 feet maximum	70 feet maximum
Overall Street Width	35 feet	41 feet
Pavement Width	30 feet	36 feet
Curb Radius	15 feet or less	25 feet or less
Drainage	Curb and Gutter (2.5 feet each side)	Curb and Gutter (2.5 feet each side)
On Street Parking	Yes (as needed)	No
Street Trees	Yes	Yes
Sidewalks	Yes (both sides)	Yes (one side)

Intersections

Noted throughout the thoroughfare plan is the tendency for the streets around the Seminary to experience peak hour traffic congestion. The combination of through traffic, limited roadway capacity, and closely spaced intersections results in periodic traffic congestion. As a part of this plan, the key intersections that are a part of the NC 98 route through downtown Wake Forest were analyzed. These intersections include the following:

- South Avenue/Wingate Street
- South Avenue/South Main Street/US 1A
- East Roosevelt Avenue/White Street
- East Roosevelt Avenue/Front Street
- North Avenue/Wingate Street

As sections of the NC 98 bypass are completed, traffic will decrease on South Avenue, Front Street, East Roosevelt Avenue, and East Wait Avenue. Most of the congestion on the route that is currently NC 98 in Wake Forest will be eliminated.

Prior to the completion of the bypass, traffic mitigation measures were studied and included concepts incorporating one-way traffic circulation, roundabouts at key intersections, and turning movement prohibitions. Concepts incorporating roundabouts and existing traffic volumes will not be able to mitigate existing level of service problems. **Table 4.2** illustrates peak hour level of service at studied intersections. Turning movement prohibitions at key intersections have the potential to improve traffic operations; however, they can also be confusing and cause more problems than they solve. Although the creation of a one-way loop around the Seminary will mitigate existing traffic congestion and has the potential to improve safety for both drivers and pedestrians, the distance around the Seminary loop makes this concept unattractive.

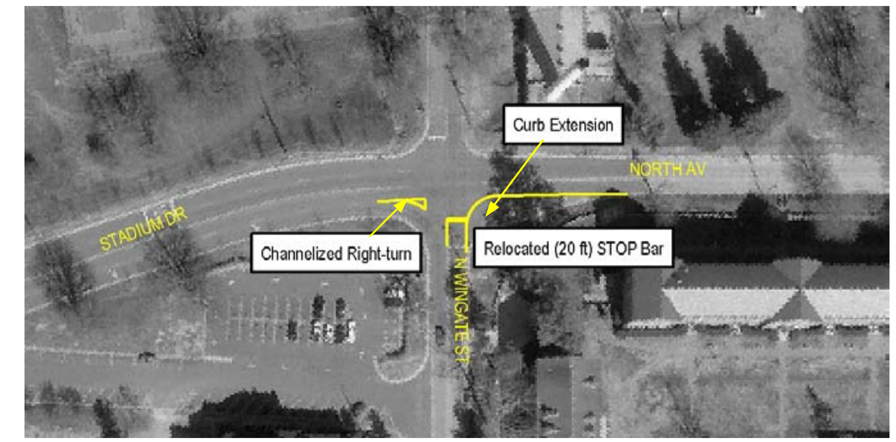
Table 4.2—Peak Hour Level of Service with Existing Traffic and Roundabouts

Intersection	Level of Service
South Avenue/Wingate Street	D (Long Queues)
South Avenue/South Main Street/US 1A	B
East Roosevelt Avenue/White Street	F (Long Queues)
East Roosevelt Avenue/Front Street	F (Long Queues)
North Avenue/Wingate Street	A

When the NC 98 bypass is complete and traffic volumes decrease on Seminary loop streets, Wake Forest will have the opportunity to develop goals and a vision for these streets and address pedestrian safety, vehicle access, and streetscape aspects appropriately with property owners, the Seminary, and the town's citizenry.

Although the intersection of North Avenue/Wingate Street/Stadium Drive functions at acceptable levels of service during peak hours, improvements were studied for this location. To improve intersection safety and operations, the following are recommended:

- Relocate the northbound (Wingate Street) STOP bar approximately 20 feet northward
- Channelize the eastbound (Stadium Drive) right-turn movement
- Reconstruct the south curbline of the westbound (North Avenue) approach



RAILROAD CONFLICTS

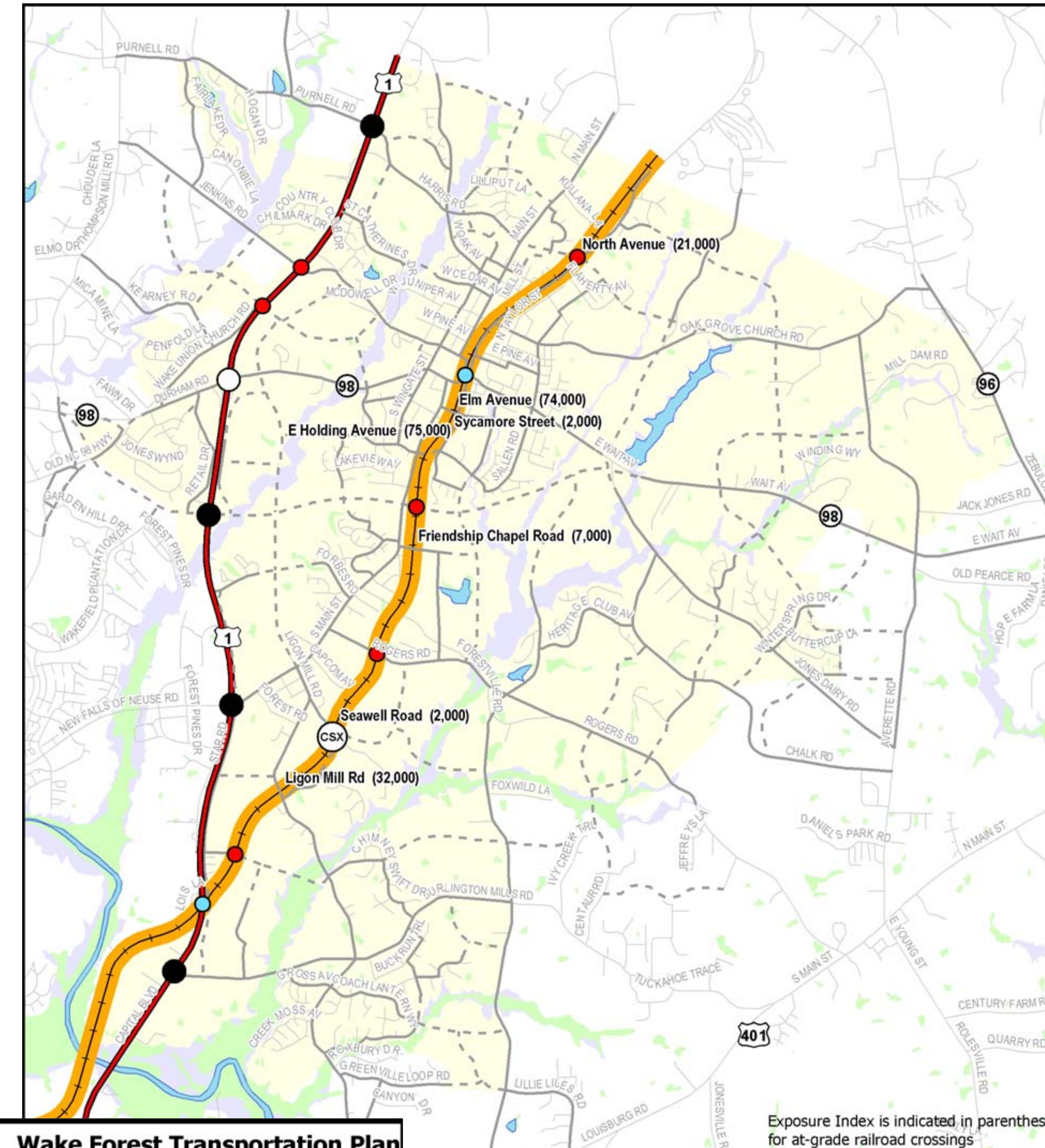
The existing railroad corridor that runs through Wake Forest's town center area is owned and operated by the CSX Railway. A study—*Traffic Separation Study for the Town of Wake Forest*—published in October of 1999 by the North Carolina Department of Transportation (NCDOT) indicates that both train frequency and speed are expected to increase in the next 15 years. This also is the "preferred corridor" for high-speed passenger rail service between Washington, D.C. and Charlotte. The study described existing operations as the following, varying by the day of the week:

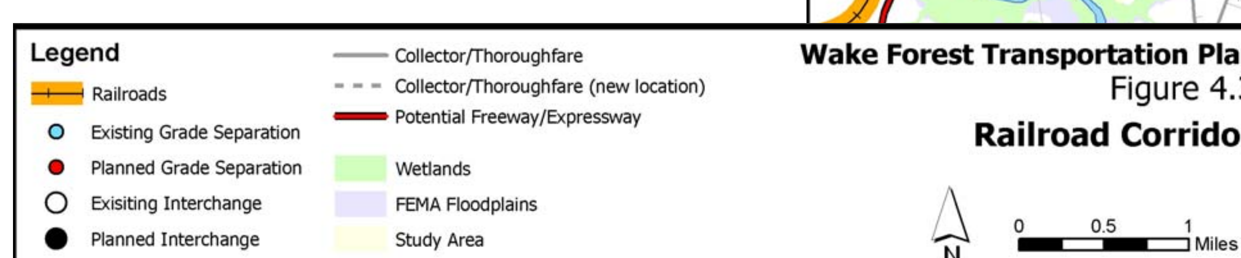
- One southbound freight train, approximately 50 cars in length, travels southbound through Wake Forest between 7:00 AM and 7:30 AM on Tuesdays and Fridays. The same train travels northbound on Wednesdays and Fridays between 6:00 PM and 6:30 PM.
- Monday through Friday, a 30- to 70-car "road switcher" train travels northbound at approximately 11:00 AM and returns southbound between 6:00 PM and 6:30 PM
- A second "road switcher" travels through Wake Forest in the mid-afternoon three days a week. The same train returns in the late afternoon and is typically 15 to 20 cars in length.

By 2015, railroad operations are expected to double, resulting in up to 10 train operations each day. In addition, train length and speed are anticipated to increase to 5,280 feet (1-mile) and 40 mph. High-speed rail service (SEHSR), increased freight operations, and expanded TTA operations will all potentially operate in this railroad corridor, exacerbating traffic operations depending on the time of crossing as well as resulting in potential noise and vibration impacts. Also, the rail corridor may be "sealed" by closing at-grade roadway and pedestrian crossings in an effort to improve safety. Currently, Wake Forest has only one grade separation with the railroad on East Roosevelt Avenue. The existing street undercrossing is two lanes and already experiences recurring traffic congestion during peak hours. In the future, one additional grade separation is planned with the railroad on the NC 98 bypass. More grade separations will be needed at Rogers Road and also at the North Loop Road.

With the current policy of improving, closing, and consolidating railroad crossings, it will be difficult to convince the railroad and NCDOT to allow any new at-grade crossings with the railroad. The transportation plan envisions retaining and improving existing railroad crossings as well as providing new railroad crossings. The following locations are where railroad crossings are planned. **Figure 4.3** illustrates the same information.

- North Loop (recommended grade separation)
- East Roosevelt Avenue (existing grade separation)
- Elm Street (potential grade separation or four-quadrant gates recommended)
- Sycamore Street (closed already)
- NC 98 bypass (planned and funded grade separation)
- Friendship Chapel Road (recommended closure)
- Forestville Road (old) (recommended to remain closed)
- Rogers Road (recommended grade separation)
- Seawell Road (recommended automated gate installation)
- Ligon Mill Road (four-quadrant gates recommended)
- Capital Boulevard (US 1) (existing grade separation)





Wake Forest Transportation Plan
Figure 4.3
Railroad Corridor

Pedestrian and Bicycle Element

Pedestrians on White Street

INTRODUCTION

Transportation plans no longer focus solely on roadway solutions. In the quest for an improved quality of life, we now strive for livable communities. A common theme of any livable community is how well it accommodates pedestrians and cyclists.

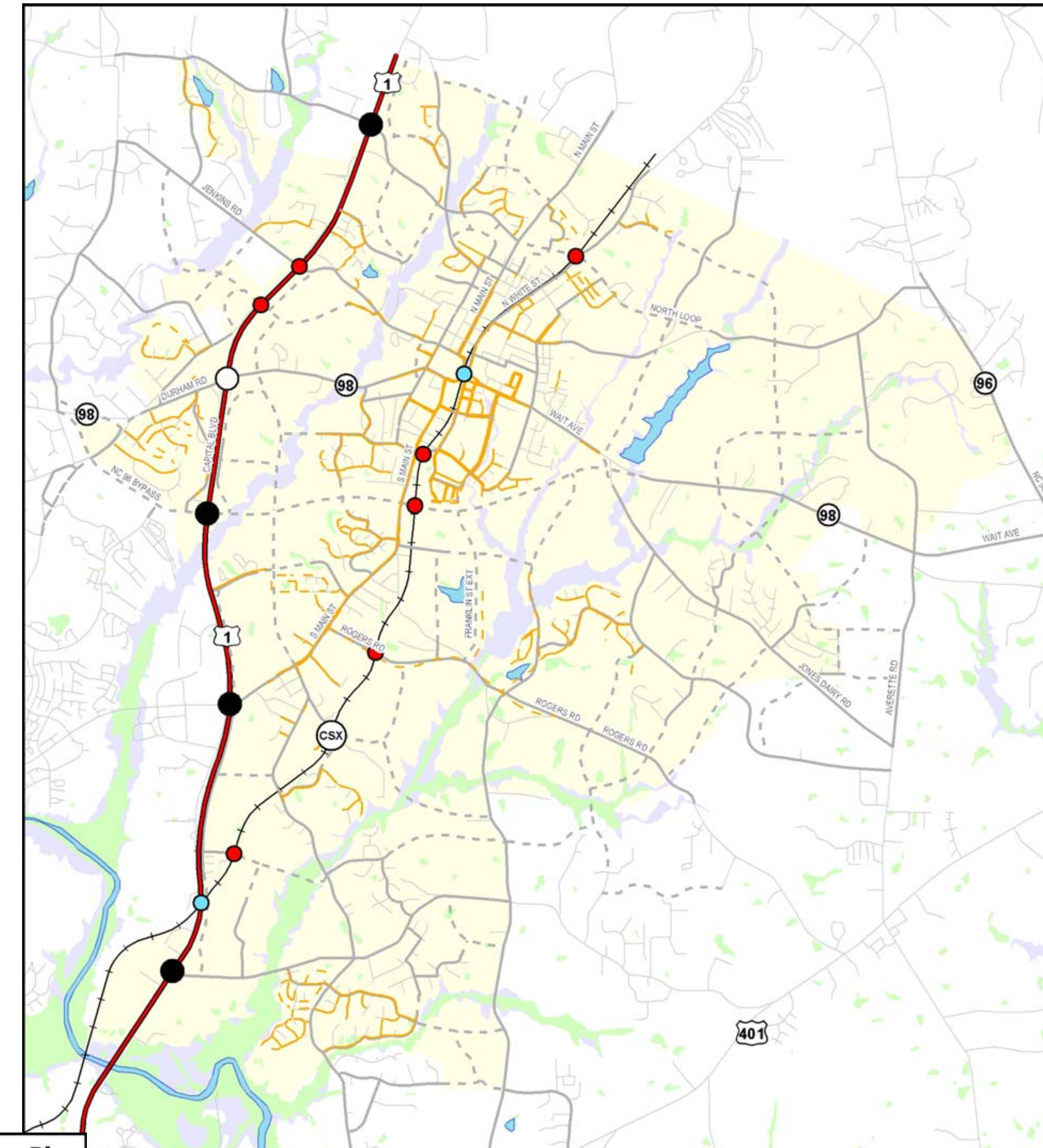
The value of walking and bicycling has numerous benefits, including:

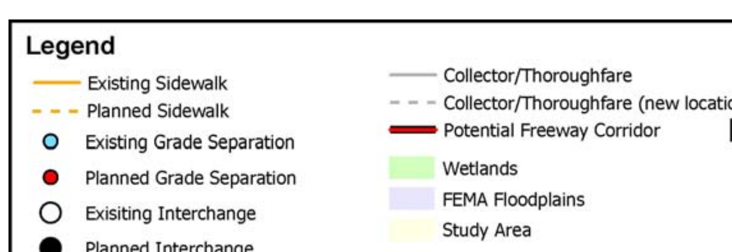
- **Personal Benefits**—Cardiovascular fitness and cost savings
- **Societal Benefits**—Reduced vehicle miles of travel, improved public health through a cleaner environment and healthier citizens, and improved mobility for those without access to private automobiles
- **Environmental Benefits**—Reduced air and noise pollution and fewer parking lots/spaces/structures

WALKING

Pedestrian can be defined both as *"undistinguished, ordinary"* and "*going on foot*." Considering both definitions, travel by foot should be ordinary and commonplace. For the most part, Wake Forest has an interconnected network of sidewalks that are in good condition throughout the downtown and in other established areas of the town.

The pride in downtown Wake Forest is evident in the efforts already undertaken by citizens and business owners to enhance the existing streetscape by painting brick patterns onto otherwise plain concrete sidewalks along White Street. This relatively inexpensive improvement adds to the charm and nostalgia of Wake Forest's bustling downtown. Evidence of the enhancement effort is not lost—pedestrians are a common sight throughout downtown, along the Seminary, and within established neighborhoods. **Figure 5.1** shows the existing sidewalk network for Wake Forest.





Wake Forest Transportation Plan
Figure 5.1
Existing and Planned Sidewalks

BICYCLING

Grade school youth can pedal for a substantial amount of time and distance at 10 mph on a bike. Destinations within a 5-mile radius are achievable for normal citizens. Although Wake Forest does not have designated bicycle facilities and routes at this time, the synthesis of interconnected streets and mixed land uses encourages making short trips by using quiet streets in neighborhoods.

For the advanced or more experienced recreational cyclist, the North Carolina Department of Transportation (NCDOT) has developed a network of bicycling highways using mostly rural roadways throughout North Carolina. While some of the designated bicycling highways are spurs that provide for connector routes and run through several counties before terminating at another bicycling highway, others are continuous north/south and east/west routes. One of these, the Mountains to Sea route, runs through Wake Forest for a short section along Purnell Road.

Mountains to Sea (NC Bike Route 2)—The Mountains to Sea bike route runs from Murphy in the North Carolina mountains to Manteo on the North Carolina coast. The route is more than 700 miles long and passes through the mountains, the Piedmont, and the coastal plain on its journey from west to east.

Throughout North Carolina and Wake County, the system of bicycling highways is marked with signs. While these routes are recognized and designated as bicycling highways (routes), there is no assurance of a cyclist's safety in travel. Cyclists choosing to use these routes must be conscious of traffic and road conditions throughout their journeys.

Pedestrians on North Main Street

IMPROVING THE NON-VEHICULAR ENVIRONMENT

Three general steps can be taken to provide an improved pedestrian and bicycle environment:

1. Integrating land use and transportation to create communities and neighborhoods that are designed for walking and cycling
2. Adopting pedestrian- and bicycle-friendly development standards, policies, and guidelines
3. Having a proactive attitude toward change

Step 3 is a critical step. *Bicycling & Walking in North Carolina, A Long-Range Transportation Plan* conceives the following vision for the future:

"All citizens of North Carolina and visitors to the state will be able to walk and bicycle safely and conveniently to their desired destinations, with reasonable access to all roadways."

The fulfillment of this vision of pedestrian- and bicycle-accessible communities requires a "can-do" attitude. Wake Forest can build on its current success and ensure that as it grows, pedestrian and bicyclist issues will be given appropriate consideration.

THE FOUR E'S OF BICYCLE AND PEDESTRIAN PLANNING

Four important components contribute to the success of a non-vehicular transportation system:

1. Engineering
2. Education
3. Encouragement
4. Enforcement

Engineering—Before there can be facilities for walking and riding bicycles, a network of pathways must be planned and designed. Good design and route choices are essential parts of a successful pathway network.

Education—Once pathway systems are developed and in-place, new and experienced cyclists need to be made aware of where these systems are and what destinations can be accessed. Motorists, pedestrians, and cyclists need to understand the "rules of the road" to keep themselves safe while operating not only on but also adjacent to these facilities.

Encouragement—The most nebulous of the four components, people need to be encouraged to walk and bicycle. The more desirable Wake Forest becomes for pedestrians and cyclists (by providing more destinations oriented for them), the more successful these modes will become. Setting a town goal to be widely recognized as bicycle friendly is a worthy idea.

Enforcement—It is critical to make sure that laws pertaining to the interaction between motorists and pedestrians/cyclists are heeded by all to ensure safety.

Cyclists

In order to develop an appropriate bicycle element, some basic terms need to be understood.

Basic Cyclists—These cyclists are casual or new adult and teenage riders less secure in their ability to ride in traffic without special accommodations. They typically prefer bike paths and bike lanes on collector or arterial streets with less exposure to fast-moving and heavy traffic. Surveys of the cycling public indicate that 80 percent of cyclists can be categorized as basic cyclists.

Advanced Cyclists—These are usually experienced cyclists who have the ability to safely ride under more typical thoroughfare conditions of higher traffic volume and speed. This group of cyclists generally prefers shared roadways as opposed to striped bike lanes and paths. Although surveys show that this group represents only about 20 percent of all cyclists, they also show that these cyclists ride about 80 percent of the bicycle miles traveled yearly.

Child Cyclists—This group includes children (aged 12 and under) on bicycles who do not fit into either classification. This group generally keeps to neighborhood streets, sidewalks, and greenways. When children venture out onto busier roadways, they typically stay on sidewalks or bicycle facilities that keep them safely away from traffic. Given the comfort level of these cyclists as well as the current availability of bike lanes, it is recommended that Wake Forest allow children and other cyclists who are uncomfortable riding in traffic to ride on sidewalks with the requirement that they yield to pedestrians.

In general, cyclists, not unlike drivers, become more experienced over time and miles of riding. As cyclists ride and gain more experience operating in traffic, they eventually graduate from the classification of a basic cyclist to an advanced cyclist more capable of operating under typical roadway conditions.

An Example of a Rural Off-Street Bike Route

Facilities

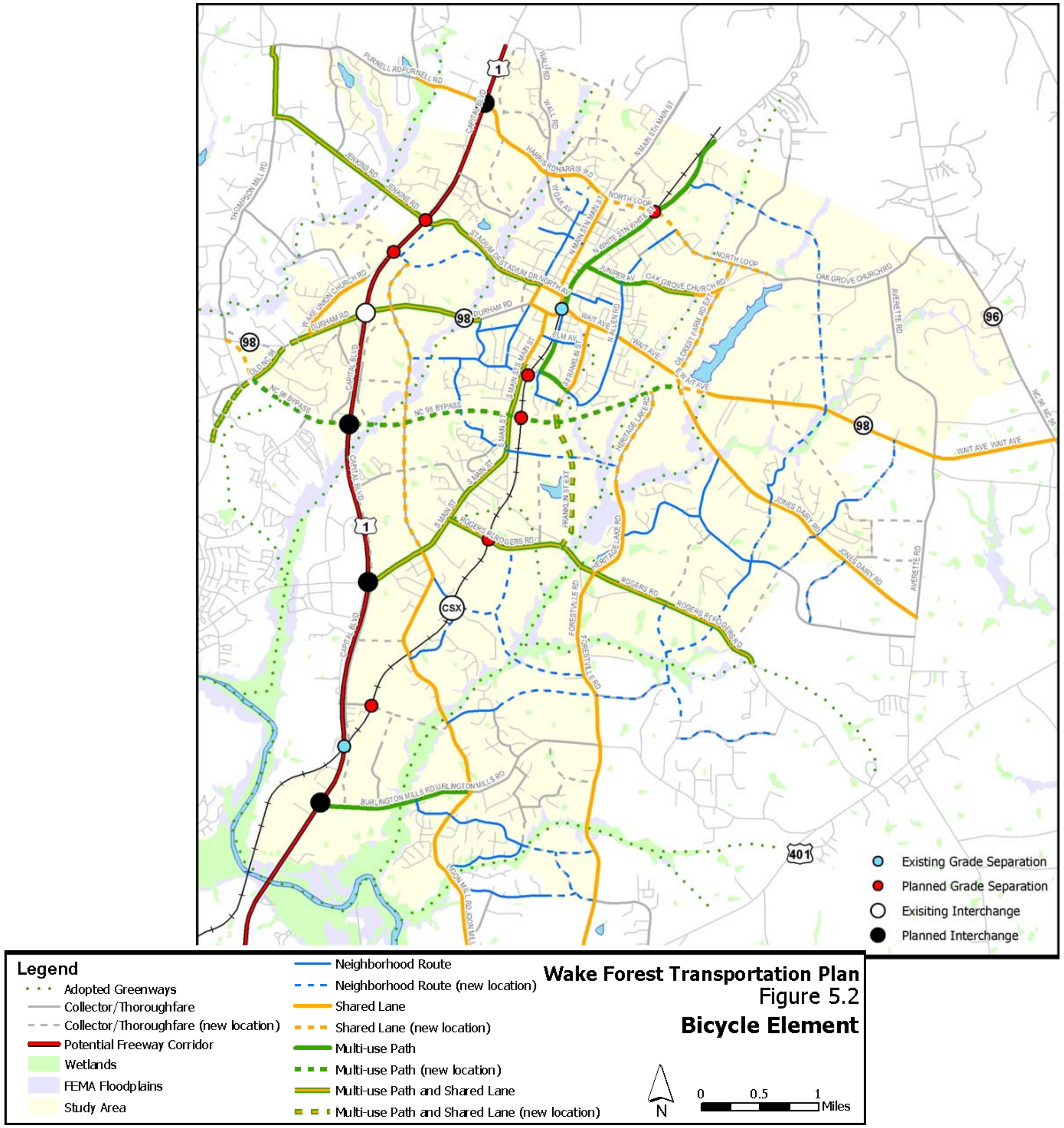
As with the definitions for the types of cyclists, it is also important to understand the differences between the types of facilities.

Shared Lane—This type of facility is often referred to as a “wide outside lane,” a “shared lane,” or a “wide curb lane.” These facilities provide extra width in the outermost travel lane on either single- or multi lane roadways to accommodate cyclists. Typically, shared lane facilities have an outer lane width of 14 feet on multi lane roadways and 15 feet on single-lane roadways. It is important to note that the lane width that is measured on this facility type does not include any curb-and-gutter adjacent to the travel lane. This facility is most appropriate on travel routes with moderate traffic volumes and is suitable for cyclists who are comfortable riding with the flow of regular traffic. These routes can be ridden by basic cyclists, but are most often preferred by advanced cyclists.

Striped Lanes—This type of facility consists of an exclusive-use area adjacent to the outermost travel lane. The area delineated for cyclists is a minimum of 4 feet wide and is marked by a solid white line on the left side and frequent signs and stenciled pavement markings indicating either “Bike Only” or another such message so as to deter vehicles other than bicycles from using the lane for travel. In situations where a striped lane encounters on-street parking, extra width is required, most often a minimum of one additional foot (5-foot total lane width). As with the shared lane facility, delineated bike lane minimum widths do not include any curb-and-gutter that may exist, as these areas are unsuitable for bicycle travel. Striped bike lanes are one of the facilities of choice for basic and child cyclists because they offer a measure of security (separation from vehicles) not found in all other facilities.

Multi-Use Paths (one side of street)—This type of facility is typically a 10-foot-wide asphalt path that runs parallel to the street and is shared by pedestrians and cyclists. These paths are set back from the curb by a planted verge area that is a minimum width of 5 feet. It is generally unacceptable to construct this type of facility where there are frequent curb cuts and intersections because the chance for conflicts between pedestrians, cyclists, and vehicles is dramatically increased. This facility type is generally suitable for all levels of cyclists, but is most often preferred by basic and child cyclists.

Signed Routes—This type of route is created in cases where no room or need exists to create additional space for cyclists. Often, signed routes lead cyclists through the “quieter” streets of a city, using neighborhood streets where traffic speeds and volumes are low. This type of route is good for cyclists of any level, provided that it is planned on streets that have low traffic volumes and speed.



Wake Forest Transportation Plan
Figure 5.2
Bicycle Element

The Plan

Sidewalks

All town center area streets, collector streets, and thoroughfares (except in unusual situations) in Wake Forest should eventually have sidewalks. This is an ambitious goal but is realistic considering that Wake Forest already has a good start with its existing sidewalk network.

In general, installing sidewalks along a roadway entails the construction of a strip of concrete 5 feet wide along one or both sides of the street, set back from the back of the curb by a minimum of 5 feet of planted verge or hardscaped area. This process is repeated until the end of the street is reached. In areas where pedestrians are expected in greater numbers and around activity centers, it is likely that wider sidewalks will be needed. The need for wide sidewalks should be evaluated on an individual basis, based on the anticipated street-level activities that are expected to occur (resulting from sidewalk cafés, street vendors, street festivals, and similar circumstances).

The following provides guidance on the placement of sidewalks throughout Wake Forest.

- **Thoroughfares**—sidewalks are required on both sides of the street, unless otherwise specified
- **Residential Collectors**—sidewalks are required on both sides of the street
- **Non-Residential Collectors**—sidewalks are required on both sides of the street unless otherwise specified

Completing the sidewalk network in Wake Forest in the future will require coordination with new development as well as careful review of new roadway construction, widening, and improvement projects. The development policies and subdivision ordinances in Wake Forest should address development-related coordination concerns. However, making sure that other roadway widening and improvement projects include sidewalk provisions will require coordination with nearby municipalities, the county, and the North Carolina Department of Transportation.

A frequently overlooked component of sidewalks are curb ramps, necessary to satisfy the Americans with Disabilities Act of 1991. A program of curb ramp installation should be adopted to retrofit existing sidewalks at appropriate locations and make sure that any new sidewalk that is installed meets design standards.

Greenways

In addition to the existing and planned sidewalk network and the planned bikeway network, natural corridors such as streams, rivers, parklands, utility easements, and areas of land unsuitable for development (e.g., steep slopes or poor soils) lend themselves well to the creation of an interconnected off-street pedestrian network. Wake Forest already has an adopted greenway plan that includes both on-street and off-street routes. Transportation plan recommendations support the adopted plan.

Bikeways

Wake Forest already has an adopted greenway and skeletal bikeway plan—intended to connect the greenway system. However, it is far from being fully implemented. The proposed bikeway network builds on and supports already adopted plans. It represents an interconnected system of pathways—both on-road and off-road— augmented with greenways and sidewalks. The recommended plan, intended to serve all levels and types of cyclists, and is planned to serve destinations such as greenways, schools, parks, and shopping opportunities. The recommended plan is shown in **Figure 5.2**. Individual bikeway recommendations are shown in **Table 5.1**.

Table 5.1–Planned Bicycle Facilities

Corridor	End Points		Facility Type	Minimum Skill Level Needed	Destinations Served
Durham Road (NC 98)	Hampton Way Drive	US 1	Two-way, off-street multi-use path (10 feet wide); shared lane (14-foot outside lanes, 12-foot inner lanes)	All levels (multi-use path), Advanced (shared lane)	Residential, Commercial
Durham Road (NC 98)	US 1	Tyler Run Drive	Two-way, off-street multi-use path (10 feet wide); shared lane (15-foot travel lanes)	All levels (multi-use path), Advanced (shared lane)	Greenway, Residential
Franklin Street	Wait Avenue	Holding Avenue	Shared lane (15-foot travel lanes)	Advanced	Park, Municipal, Commercial, Residential
Franklin Street extension	Holding Avenue	Rogers Road	Two-way, off-street multi-use path (10 feet wide); shared lane (14-foot travel lanes)	All levels (multi-use path), Advanced (shared lane)	Park/School, Commercial, Residential
Harris Road (and ext.)/North Loop	Capital Boulevard (US 1)	East Wait Avenue (NC 98)	Shared lane (14-foot outside lanes)	Advanced	Greenway, Commercial, Residential
Heritage Lake Road (and ext.)/ Forestville Road	East Wait Avenue (NC 98)	Louisburg Road (US 401)	Shared lane (14-foot outside lanes, 12-foot inner lanes)	Advanced	Greenway, Park/School, Residential
Jenkins Road	Horse Creek Greenway	Capital Boulevard (US 1)	Two-way, off-street multi-use path (10 feet wide); shared lane (15-foot travel lanes)	All levels (multi-use path) Advanced (shared-lane)	Greenway, Commercial, Residential
Jones Dairy Road	NC 98 Bypass	Averette Road	Shared lane (14-foot outside lanes)	Advanced	Residential
Juniper Avenue	North White Street	Planned Smith Creek Greenway	Two-way, off-street multi-use path (10 feet wide)	All levels	Greeway, Park, Residential
Ligon Mill Road	South Main Street	Burlington Mills Road	Shared lane (14-foot outside lanes, 12-foot inner lanes)	Advanced	Greenway, Residential, Commercial
Ligon Mill Road	Burlington Mills Road	Louisburg Road (US 401)	Shared lane (14-foot outside lanes)	Advanced	Greenway, Residential
Ligon Mill Road extension	Durham Road (NC 98)	South Main Street	Shared lane (15-foot travel lanes)	Advanced	Greenway, School, Residential
North Main Street	Harris Road	North Avenue	Shared lane (15-foot travel lane)	Advanced	School, Commercial, Residential
North White Street	Wake/ Franklin County line	Spring Street	Two-way, off-street multi-use path (10 feet wide); shared lane (15-foot travel lanes)	All levels (multi-use path) Advanced (shared-lane)	Commercial, Municipal, Residential
Purnell Road	Horse Creek Greenway	Capital Boulevard	Shared lane (15-foot travel lanes)	Advanced	Greenway, Residential
Rogers Road	South Main Street	Forestville Road	Two-way, off-street multi-use path (10 feet wide); shared lane (14-foot outside travel lanes, 12-foot inner lanes)	All levels (multi-use path) Advanced (shared-lane)	Greenway, School, Residential
Rogers Road	Forestville Road	Louisburg Road (US 401)	Two-way, off-street multi-use path (10 feet wide); shared lane (14-foot travel lanes)	All levels (multi-use path) Advanced (shared-lane)	School, Residential
Seminary Loop*	-	-	Shared lane (15-foot travel lanse)	Advanced	School, Commercial, Residential
South Main Street	South Avenue	Holding Avenue	Shared lane (15-foot travel lanes)	Advanced	Park/School, Commercial, Residential
South Main Street	Holding Avenue	Planned NC 98 Bypass	Two-way, off-street multi-use path (10 feet wide); shared lane (14-foot travel lanes)	All levels (multi-use path) Advanced (shared-lane)	Park/School, Commercial, Residential
South Main Street	Planned NC 98 Bypass	Capital Boulevard	Two-way, off-street multi-use path (10 feet wide); shared lane (14-foot outside travel lanes, 12-foot inner travel lanes)	All levels (multi-use path) Advanced (shared-lane)	Greenway, School, Commercial, Residential
Stadium Drive	Capital Boulevard (US 1)	Wingate Street	Two-way, off-street multi-use path (10 feet wide); shared lane (14-foot travel lanes)	All levels (multi-use path) Advanced (shared-lane)	Greenway, School, Park, Commercial
Wait Avenue/Roosevelt Avenue	White Street	Planned North Loop	Shared lane (15-foot travel lanes)	Advanced	Greenway, Commercial, Residential
Wait Avenue	Planned North Loop	Zebulon Road (NC 96)	Shared outside lane (14-foot outside travel lanes, 12-foot inner travel lanes)	All levels (multi-use path) Advanced (shared-lane)	Residential

* = The Seminary Loop is made up of Wingate Street, South Avenue, Front Street, and North Avenue

Transit Element

INTRODUCTION

TTA Vanpool Service

A fallacy in civic debate is to think that public transportation is a solution to traffic congestion. Another fallacy is that transit should "pay for itself" through fare box collections. Adequate public transportation offers a choice in the way we travel. Transit cannot and should not be expected to remedy our lengthening commute times, worsening traffic congestion, or diminishing air quality.

Transit riders are generally categorized in one of two groups: captive or choice. Captive transit riders use transit because they must, due to lack of access to a personal vehicle or because of a physical challenge. On the other hand, choice transit riders leave their vehicles at home to use their travel time more wisely and perhaps spare the operational and parking costs of driving. This choice is even more important as we consider the mobility needs of society's youth, the elderly, and the disabled.

The development and implementation of a successful transit initiative for Wake Forest will require the cooperation and attention of numerous agencies at the local, regional, and state level.

CHALLENGES

A number of challenges need to be addressed to effectively plan and operate a successful transit system in Wake Forest. These challenges include:

- **Population and Land Use**—The core of Wake Forest is made up of older and densely mixed land use neighborhoods. The outskirts of the town are largely suburban, have widely separated land uses, and have lower densities. Transit service is much more easily and economically provided and is more likely to succeed in areas of higher density and mixed land uses.
- **Education**—Current and potential riders need to be made aware that services are available for daily trips of all types, not only when other arrangements fall through.
- **Encouragement**—Riders need to be encouraged to take transit for recreation, entertainment, and shopping activities in addition to need based activities.
- **Funding**—Current funding is insufficient to meet the demand for transit related services.

EXISTING SERVICES

The challenges and obstacles to providing good and efficient transit service are not limited to Wake Forest. Throughout Wake County, transit providers struggle with the similar challenges as they provide transit services. Currently, a number of transit service providers operate in the county. However, TTA is the only provider currently serving Wake Forest.

Triangle Transit Authority

While TTA currently operates regional bus service throughout the Triangle on 16 fixed routes, none serve Wake Forest. **Table 6.1** shows operational statistics of TTA's Regional Bus service.

Table 6.1 – TTA Operations

Weekday Ridership	
total passengers	2,550
Revenue Hours of Service	
weekday	360
Revenue Miles of Service	
weekday	3,746

Source: Triangle Transit Authority, April 2002

To serve Wake Forest and other areas outside the service areas of the regional bus service, TTA operates an extensive vanpool service. Currently, 49 vanpools are in operation, 1 of which originates in Wake Forest. The Wake Forest vanpool operates between the town and Research Triangle Park five days a week for riders whose working hours are 8:00 AM to 5:00 PM.

Vanpool fares are charged by the month at variable rates depending on the number of daily miles the vanpool travels. For additional information on TTA's services reference the following link:

- www.rideTTA.org

FUTURE TTA SERVICES

Although Wake Forest receives little in the way of transit services today, service expansions envisioned by TTA will dramatically improve Wake Forest's accessibility by transit. In a few short years, TTA will begin operating the first phase of Regional Rail service between Raleigh and Durham.

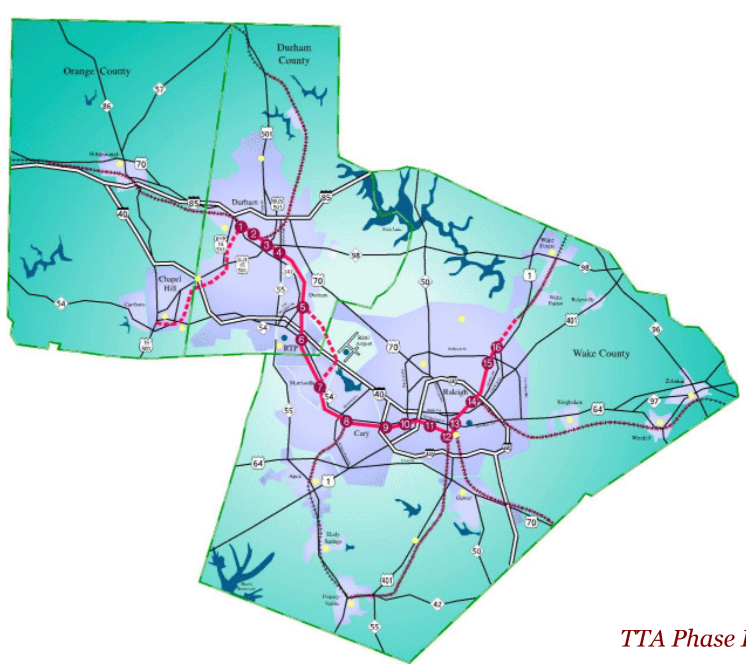
When the system opens in late 2007/early 2008, it will be 35 miles long and will connect Raleigh, Cary, Morrisville, RTP, and Durham. The service will share the active freight (Norfolk Southern and CSX) and passenger rail (AMTRAK) corridor owned by the North Carolina Railroad (NCRR) and will use diesel multiple units (DMU) to carry passengers.

Regional rail service is planned to run in both directions, 18 hours a day, 7 days a week on 15-minute peak hour and 30-minute off-peak hour headways. Daily ridership is estimated to be between 25,000 and 35,000 riders per day. By comparison, the 25,000 to 35,000 people that are projected to ride the train represent the full capacity of a new six-lane divided highway between Raleigh and Durham.

Station Locations

In Phase I of the Regional Rail service, stations are planned for the following locations:

1. Duke Medical Center
2. 9th Street/Duke East
3. Downtown Durham
4. Alston Avenue/NC Central University
5. North Research Triangle Park
6. South Research Triangle Park
7. Northwest Cary
8. Downtown Cary
9. West Raleigh
10. State Fairgrounds
11. NC State University
12. Downtown Raleigh
13. State Government Center
14. Highwoods
15. New Hope Church Road
16. Spring Forest Road



TTA Phase I—Regional Rail Route

In Phase II, two additional stations are expected to be located at:

17. NE Regional Center, near the I-540/US 1 interchange
18. Durant Road

Schedule

As the *Regional Transit Plan* continues with implementation, it is following the federally (FTA) mandated project development process. Future steps to this process include:

- Complete Final Design—2001 to 2003
- Start Construction—2003 to 2007/2008
- Start Operation—2007/2008

Source: Triangle Transit Authority, Regional Rail System - Draft Environmental Impact Statement (DEIS), Fall 2000

Although the regional rail component of the *Regional Transit Plan* is the most widely understood and publicized portion of this plan, it also includes the addition of local feeder bus services and the alteration of regional bus service to better accommodate the transit patrons of the Triangle area. While the TTA regional rail system will not extend to Wake Forest in its first phases, feeder bus services, vanpools, park-and-ride lots, and altered regional bus service are all services that may serve Wake Forest.

Feeder bus routes will collect and shuttle patrons to rail stations for dispersion throughout the system. As final plans are developed, appropriate feeder bus routes, some utilizing existing transit services, will be planned.

Future Expansions

Wake Forest will not receive regional rail service in initial phases of the TTA *Regional Transit Plan;* however, transit service expansions in the US 1/Seaboard Coast Line railroad corridor are conceivable. **Figure 6.1** illustrates this corridor.

Wake Forest is a hub of the rural but developing portions of northern Wake County and southern Franklin County. Wake Forest also has vibrant commercial and reasonably dense residential areas already in existence along the railroad as well as plans for large-scale development near the railroad corridor. Wake Forest's railroad corridor connects to the planned endpoint of TTA's regional rail line from Spring Forest Road to downtown Wake Forest. However, understanding that transit ridership must exist before major investments in rail can be made, service could initially be provided by bus using US 1, Falls of the Neuse

Road, or another thoroughfare. **Figure 6.2** illustrates potential transit corridors in the Wake Forest vicinity.

As ridership and demand grow, the transit service could transition to a rail transit operation using the existing railroad corridor. To streamline initial transit services while they are operating on existing streets, transit priority treatments at key intersections and along roadways could be constructed.

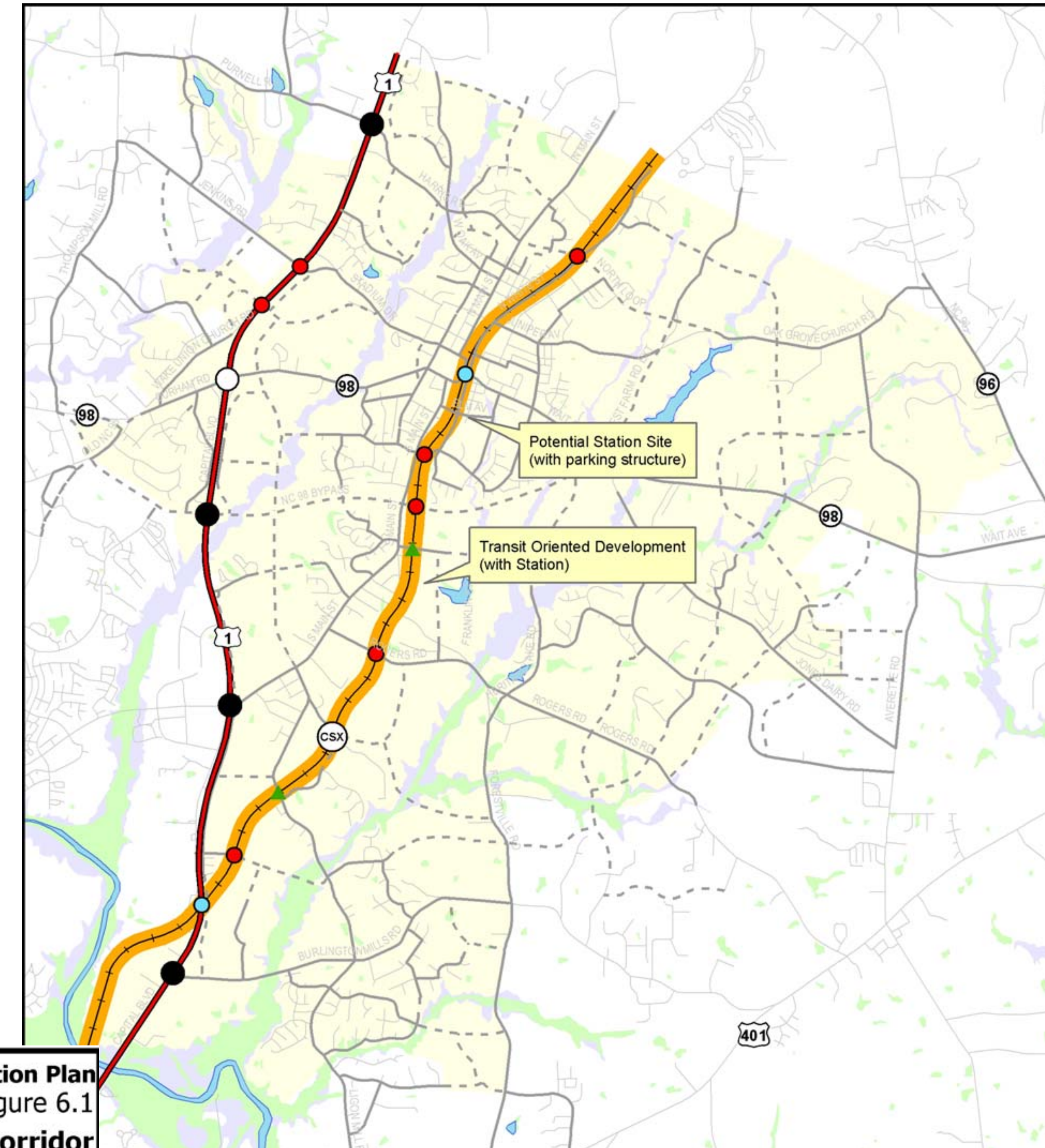
In addition to the extension of regional rail service, a connection between Wake Forest and Rolesville could be created, most likely by bus transit.

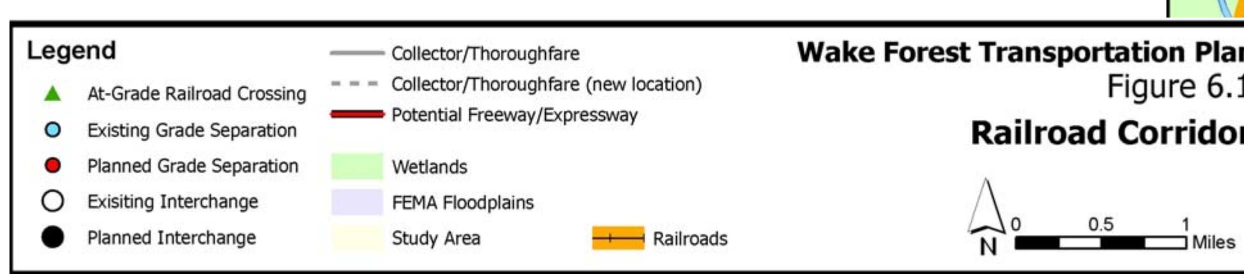
SOUTHEAST HIGH SPEED RAIL (SEHSR)

The Southeast High Speed Rail is an initiative that is planned to bring high speed rail service to the Washington, D.C. to Charlotte rail corridor. The corridor selected by initial studies is the CSX railroad corridor that runs throught Wake Forest. More detailed studies of actual operating impacts including vibration and speed analysis will be conducted as a part of ongoing studies related this initiative. More information can be found on the SEHSR at the following location:

- www.sehsr.org

With the corridor running through Wake Forest selected as the preferred route for the SEHSR, Wake Forest should petition for a station in the town. With a station in the town, not only will the citizens be served, but train speeds will be lower, reducing potential noise and vibration.





Wake Forest Transportation Plan
Figure 6.1
Railroad Corridor

RECOMMENDATIONS

Residents of Wake Forest have expressed the desire for a choice in how they travel within Wake Forest and throughout the Triangle area. To increase the chance of making reality out of desire, the following initial transit supportive steps are recommended:

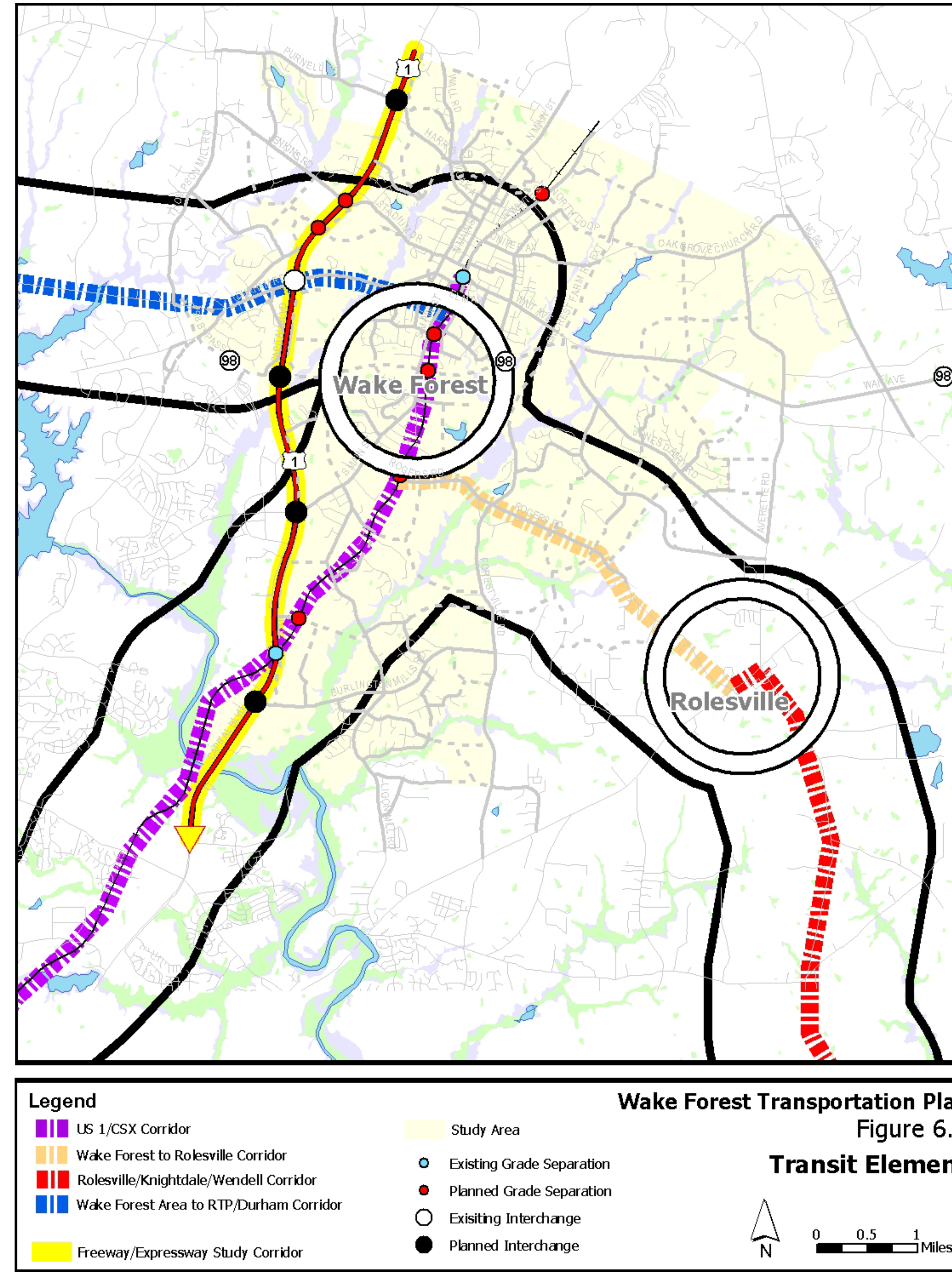
- Support cooperative efforts with NCDOT, CAMPO, and TTA on intracity transit initiatives such as Phases I and II of the *Regional Transit Plan*
- Begin discussions with TTA regarding the connection of regional rail services with feeder bus or other transit services to Wake Forest
- Continue the program of planning and constructing sidewalks and bikeways
- Identify potential park-and-ride lot locations and station sites
- Increase the potential for transit ridership by identifying and encouraging new development and redevelopment opportunities that support future transit plans
- Identify candidate station sites
- Promote future transit plans by encouraging transit-supportive design features in areas targeted (true compact mixed-use developments) for transit service such as likely station sites
- Work with TTA to develop coordinated park-and-ride and feeder/express bus services to support the future regional transit system**
- Coordinate roadway improvement projects that support rather than complicate and/or compete with transit plans**
- Conduct a transit services study to determine residents' specific desires toward services that could be provided

***Accomplished through coordination between NCDOT, Wake County, TTA, and CAMPO*

Success

For overall success to be achieved, Wake Forest must make commitments to supporting transit initiatives already in progress, developing transit initiatives of their own, and in some cases, providing transit services. Efforts independent of NCDOT and TTA must be initiated to promote mobility choices throughout the county. These include:

- Constructing bikeways, greenways, and sidewalks
- Compiling an inventory of short- and long-term transit service needs
- Establishing development policies that support and encourage transit use



Wake Forest Transportation Plan
Figure 6.2
Transit Element

Implementation Plan

INTRODUCTION

All long-range plans benefit from a good implementation plan. Recommendations in the *Wake Forest Transportation Plan* will be contingent on numerous elements, but none more important than the ability for the town to secure funding for recommended improvements. To adopt and implement the plan, the Town of Wake Forest will need to work with the following:

- Wake Forest's citizens and businesses
- Capital Area Metropolitan Planning Organization (CAMPO)
- North Carolina Department of Transportation (NCDOT)
- Triangle Transit Authority (TTA)
- North Carolina Board of Transportation
- Elected leadership in the North Carolina General Assembly
- Neighboring jurisdictions (Rolesville, Raleigh, and Franklin County)

Transportation improvement funds are scarce and competition for them is fierce. Wake Forest will not be able to rely solely on State Transportation Improvement Program (TIP) funds to implement plan recommendations.

To fully implement the plan, the town will have to identify stable, timely, and equitable methods of funding. Wake Forest already has regulations that require development to fund certain roadway improvements. Wake Forest should continue to require roadway improvements of new development. In addition, Wake Forest may want to follow a course of action similar to that of Garner and Cary—to pass a bond referendum to fund transportation system improvements recommended in their respective adopted transportation plans.

SHORT-TERM ELEMENTS

Plan Adoption Process

- Public open houses and other presentations
- Recommend adoption to Wake Forest Board
- Adoption by Wake Forest Board
- Plan review by the CAMPO Technical Coordinating Committee (TCC)
- Adoption by the North Carolina Board of Transportation

Thoroughfare Plan Amendments

- Adoption of a resolution by the Town Board to amend the official *Wake Forest Thoroughfare Plan*
- Notify CAMPO of the Wake Forest's resolution to amend their official *Wake Forest Thoroughfare Plan* with the following:

1. **Capital Boulevard (US 1)**—study the potential for freeway conversion from the Outer Loop to the Wake County line
2. **Thompson Mill Road**—re-designate from collector street to minor thoroughfare
3. **Wake Union Church Road**—re-designate from collector street to major thoroughfare
4. **Wingate Street**—remove from thoroughfare plan
5. **Wingate Street realignment**—new minor thoroughfare

- Grade separations and interchanges are recommended at the following locations in conjunction with the recommendation for the conversion of US 1 to a freeway (or as a part of other already programmed TIP projects):

6. **Purnell Road/Harris Road** (interchange)
7. **Stadium Drive/Jenkins Road** (grade separation)
8. **Wake Union Church Road** (grade separation)
9. **NC 98** (existing interchange)
10. **NC 98 bypass** (programmed single point interchange)
11. **South Main Street/New Falls of the Neuse Road** (interchange)
12. **Burlington Mills Road** (interchange)

- Recommended railroad grade separations are at the following locations:

13. **North Loop** (future)
14. **East Roosevelt Avenue** (existing)
15. **Holding Avenue** (future)
16. **NC 98 bypass** (programmed)
17. **Rogers Road** (future)

Priority Setting

- Facilitate Town Board prioritization of transportation improvements by using and demonstrating CAMPO project scoring methods
- Request inclusion of high-priority projects in the next version of the TIP

Intersection Improvements

Capital Boulevard (US 1)/Jenkins Road/Stadium Drive—Construct an additional westbound (Stadium Drive) left-turn lane. Revise signal phasing and timing to a split phase operation for east/west streets (Stadium Drive/Jenkins Road).

Railroad Crossing Improvements

With the potential for increased railroad operations and the focus on railroad crossing safety, the following locations are recommended to be upgraded to rubberized, steel, or concrete crossings with four quadrant crossing arms:

- **Elm Avenue**
- **Holding Avenue**
- **Ligon Mill Road**

Follow-Up Studies/Plans

Prepare more detailed plans/studies for the following corridors:

- **Stadium Drive**—Prepare a streetscape plan for this corridor from Capital Boulevard (US 1) to Wingate Street
- **South Main Street**—Prepare a streetscape plan for this corridor from Holding Avenue to the planned NC 98 bypass
- **East Wait Avenue/East Roosevelt Street**—Prepare a streetscape plan for this corridor from the NC 98 bypass to Front Street
- **Seminary Loop—**Conduct a feasibility study to analyze traffic operations and street function on Front Street, South Avenue, North Avenue, and Wingate Street when the NC 98 bypass is nearing completion
- **Capital Boulevard (US 1)—**support CAMPO corridor study initiatives
- **Capital Boulevard (US 1)—**develop a plan in conjunction with adjacent jurisdictions to manage access along Capital Boulevard
- **Update** the transportation plan in five years

Long-Term Elements

Roadway Improvement Projects

- Prepare functional plans for high priority transportation improvements and identify required rights-of-way
- Reserve or protect corridor rights-of-way for priority transportation improvement projects through adoption by the Town Board of an official *Roadway Corridor Map*
- Work with state agencies to get approval for permits and assistance in acquiring right-of-way for projects

Pedestrian and Bicycle Elements

- Prioritize and design non-roadway related sidewalk, pathway, greenway, and bikeway improvements that are not dependent on roadway improvement projects
- Work with Wake County Schools to provide good non-vehicular connections through new school properties

Approximate Plan Costs

The following table is a summary cost estimate for the full buildout of recommendations in the *Wake Forest Transportation Plan*. The costs presented are in 2002 dollars and do not account for inflation to the anticipated construction year.

Table 7.1—Transportation Program Cost

Element	Quantity	Total Cost
Roadway Projects		
NC 98 Bypass	-	$ 55,000,000
Roadway Widening	40 miles	$ 116,500,000
Roadways on New Location	12.5 miles	$ 49,500,000
Collector Streets	32 miles	$ 96,700,000
Grade Separations	2	$ 5,990,000
Interchanges	3	$ 21,550,000
Pedestrian Enhancement Projects		
Sidewalk Program	11.5 miles	$ 1,430,000
Other Elements		
Wetland Mitigation	-	$ 1,130,000
Bridges/Culverts (natural features)	59 crossings	$ 6,430,000
Total Program Cost		**$ 354,230,000**

Appendix A—Corridor Profiles

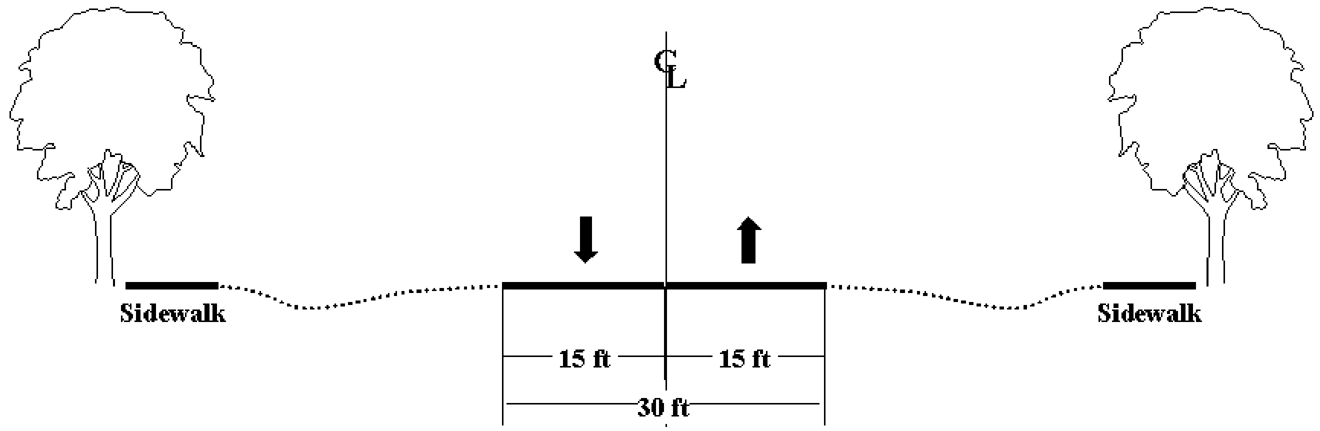
Contents

Averette Road from Oak Grove Church Road (SR 1942) to Wait Avenue (NC 98)

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	60 ft	2	None	45 mph	Major	n/a	12,000
2025	30 ft	70 ft	2	None	45 mph	Secondary-Major	6,100	12,000

Looking South Toward Wait Avenue (NC 98)

Typical Cross Section



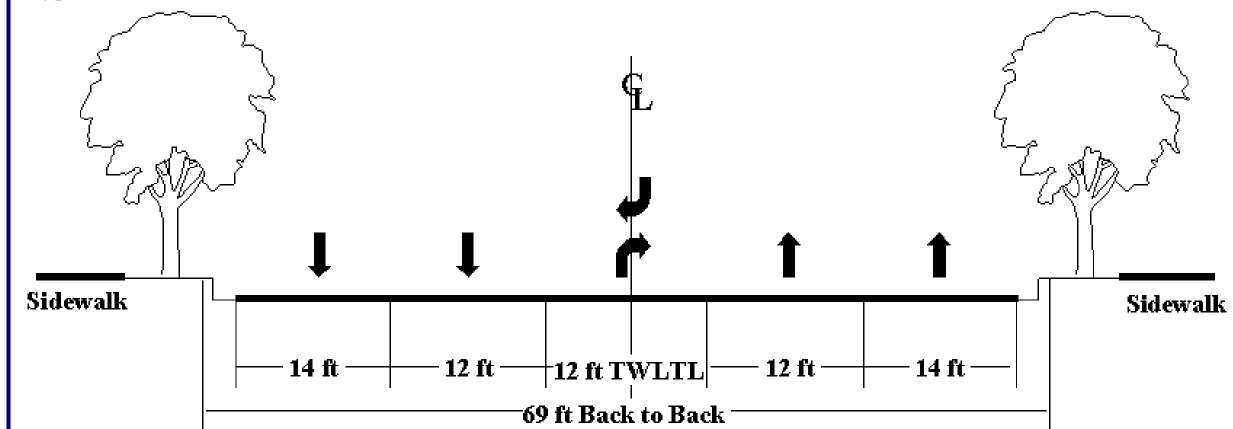
Two Lanes

Burlington Mills Road from Capital Boulevard (US 1) to Ligon Mill Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	23 ft	60 ft	2	None	45 mph	Major	7,800	17,500
2025	69 ft	90 ft	4	Two-way Left-turn Lane	45 mph	Local-Major	16,000	32,000

Looking East Toward Ligon Mill Road

Typical Cross Section



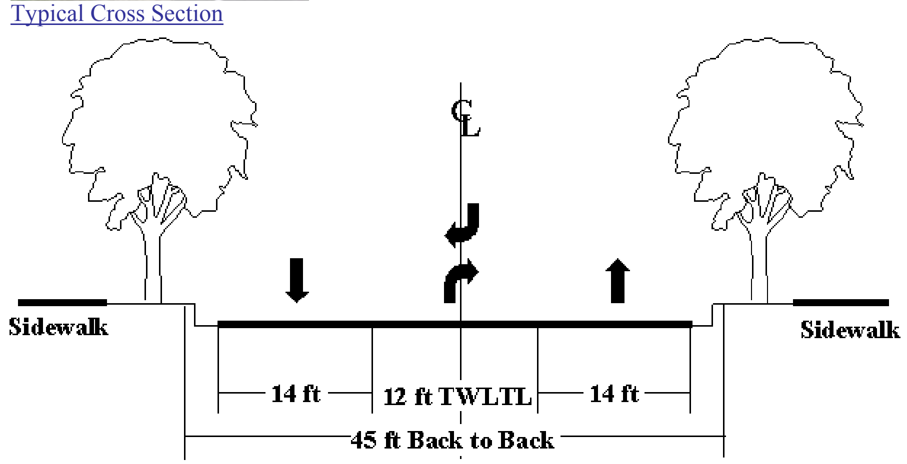
Five Lanes

Burlington Mills Road from Ligon Mill Road to Forestville Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	22 ft	60 ft	2	None	45 mph	Major	n/a	12,000
2025	45 ft	90 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Local-Major	11,200	18,000

Looking East Toward Forestville Road

Typical Cross Section



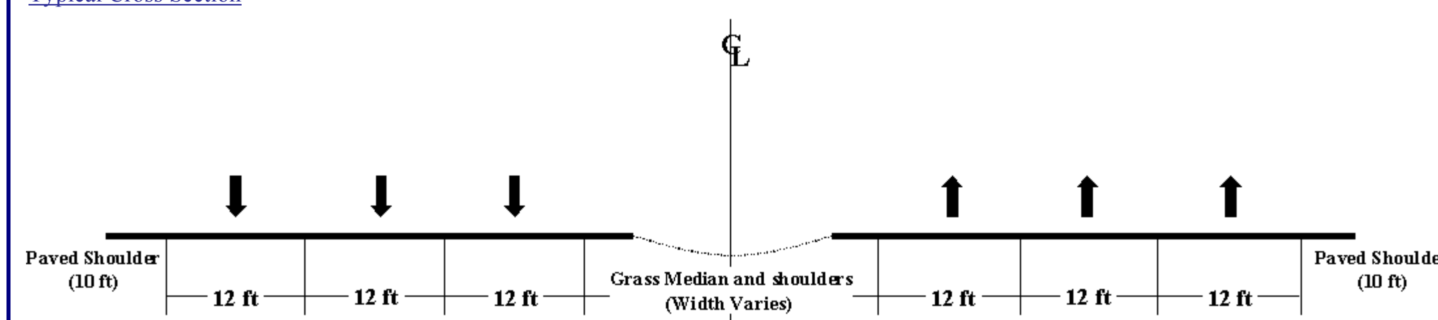
Three Lanes

Capital Boulevard (US 1) from Wake County Line to Purnell Road/Harris Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	200 ft	4	Landscaped Median	55 mph	Major	n/a	38,000
2025	n/a ft	200 ft	6	Landscaped median with guardrail	60 mph	Primary-Major	60,000	95,000

Looking North Toward Wake County Line

Typical Cross Section



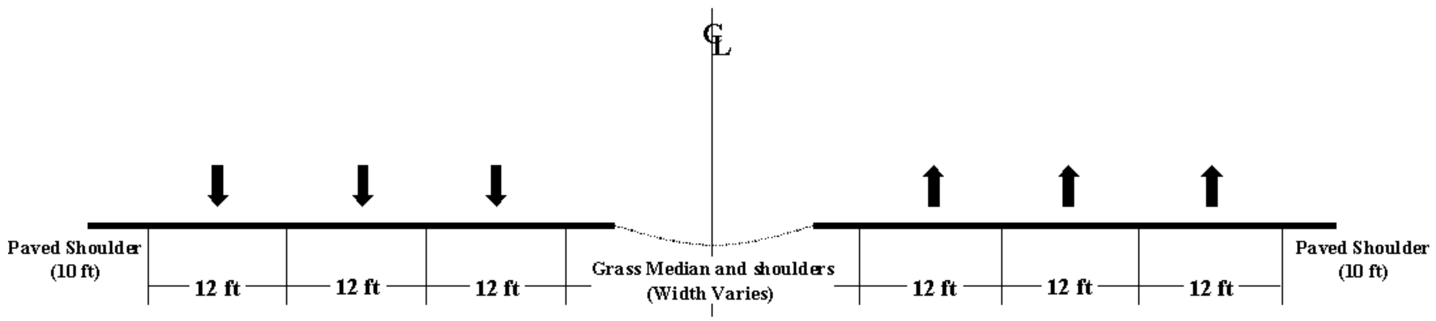
Six Lane Freeway

Capital Boulevard (US 1) from Purnell Road/Harris Road to Stadium Dr/Jenkins Rd

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	200 ft	4	Landscaped Median	55 mph	Major	28,400	38,000
2025	n/a ft	200 ft	6	Landscaped median with guardrail	60 mph	Primary-Major	62,800	95,000

Looking South Toward Stadium Drive/Jenkins Road

Typical Cross Section



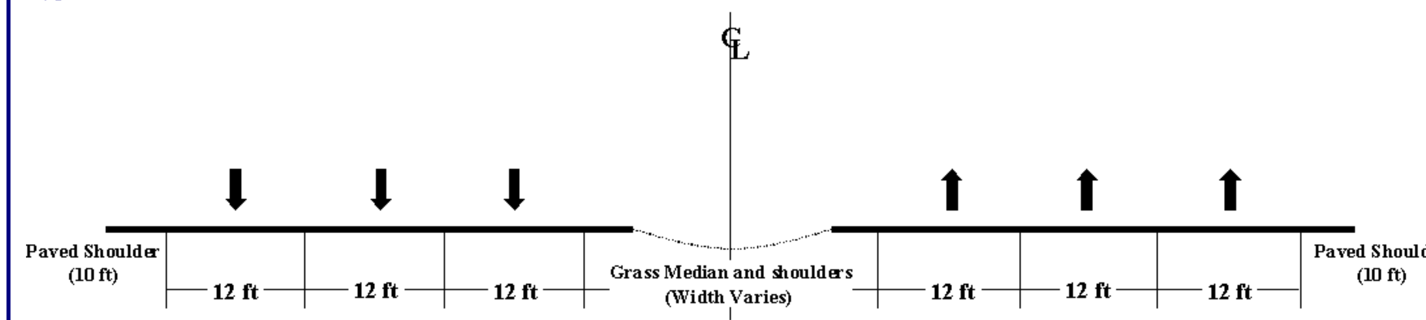
Six Lane Freeway

Capital Boulevard (US 1) from Stadium Drive/Jenkins Road to NC 98 Bypass

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	250 ft	4	Landscaped Median	55 mph	Major	33,900	38,000
2025	n/a ft	250 ft	6	Landscaped median with guardrail	60 mph	Primary-Major	65,700	95,000

Looking North Toward Stadium Drive/Jenkins Road

Typical Cross Section



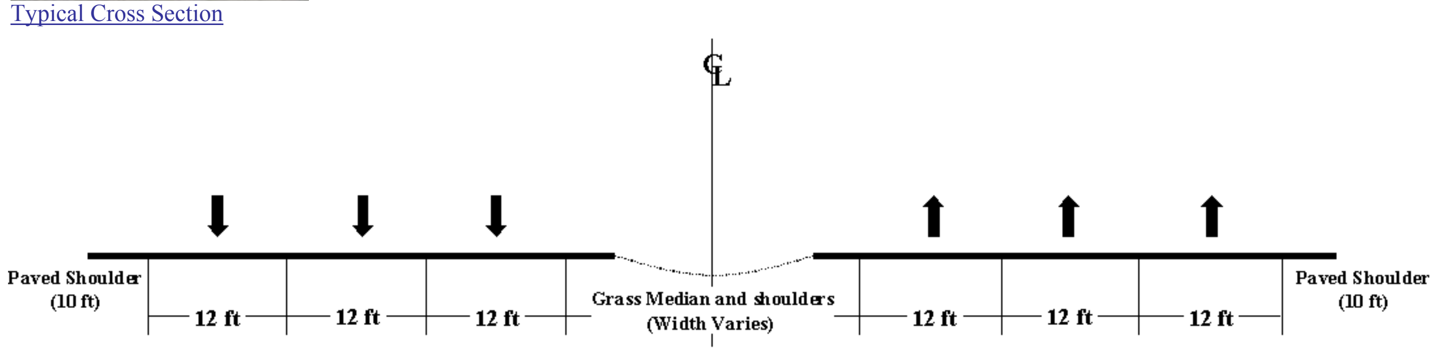
Six Lane Freeway

Capital Boulevard (US 1) from NC 98 Bypass to South Main Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	200 ft	4	Landscaped Median	55 mph	Major	28,400	38,000
2025	n/a ft	200 ft	6	Landscaped median with guardrail	60 mph	Primary-Major	95,600	95,000

Looking South Toward South Main Street (US 1A)

Typical Cross Section



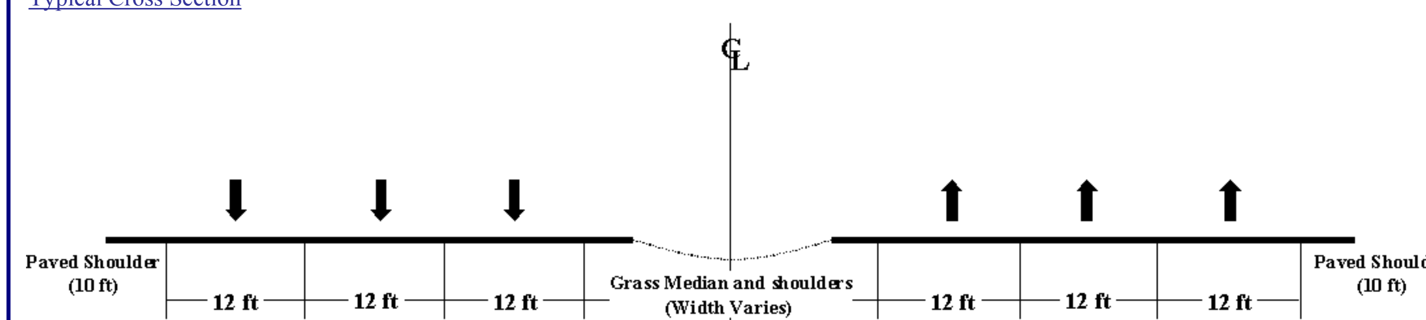
Six Lane Freeway

Capital Boulevard (US 1) from South Main Street to Burlington Mills Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	250 ft	4	Landscaped Median	55 mph	Major	35,000	38,000
2025	n/a ft	250 ft	6	Landscaped median with guardrail	60 mph	Primary-Major	97,300	95,000

Looking North Toward South Main Street (US 1A)

Typical Cross Section



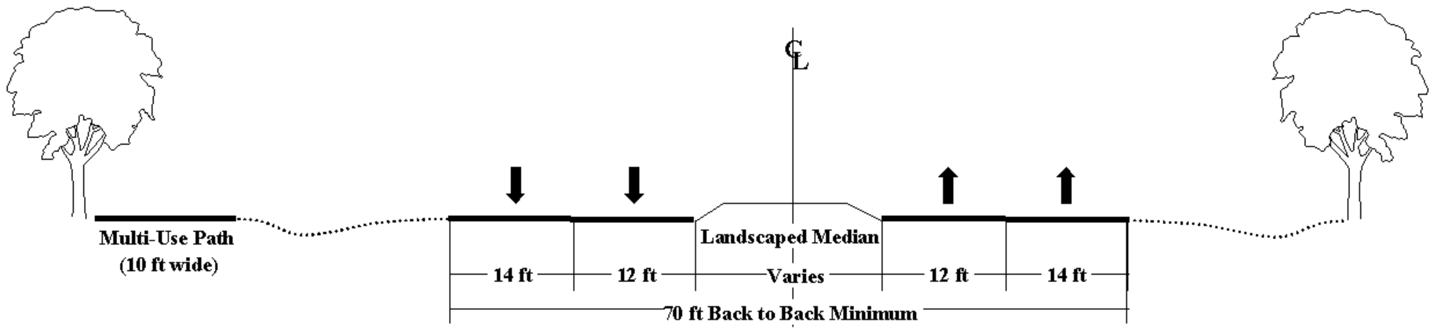
Six Lane Freeway

Durham Road (NC 98) from the Planned NC 98 Bypass to Wake Union Church Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	32 ft	120 ft	2	None	55 mph	Major	n/a	17,500
2025	70 ft	120 ft	4	Landscaped Median	45 mph	Secondary-Major	17,500	38,000

Looking East Toward Old NC 98

Typical Cross Section



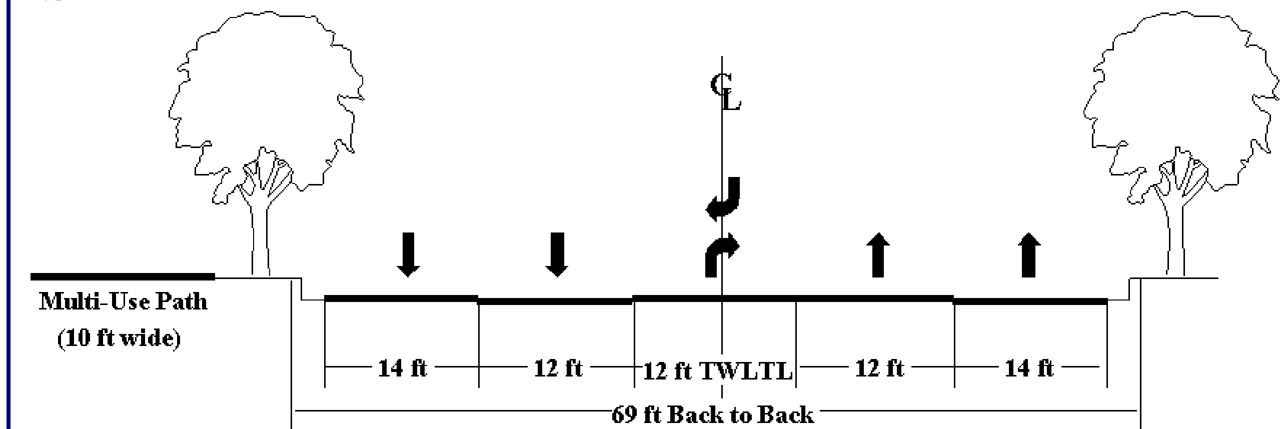
Four Lanes with a Landscaped Median

Durham Road (NC 98) from Wake Union Church Road to US 1 Northbound Ramps

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	75 ft	140 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Major	19,700	18,000
2025	75 ft	140 ft	4	Two-way Left-turn Lane	45 mph	Secondary-Major	8,500	32,000

Looking West Toward Old NC 98

Typical Cross Section



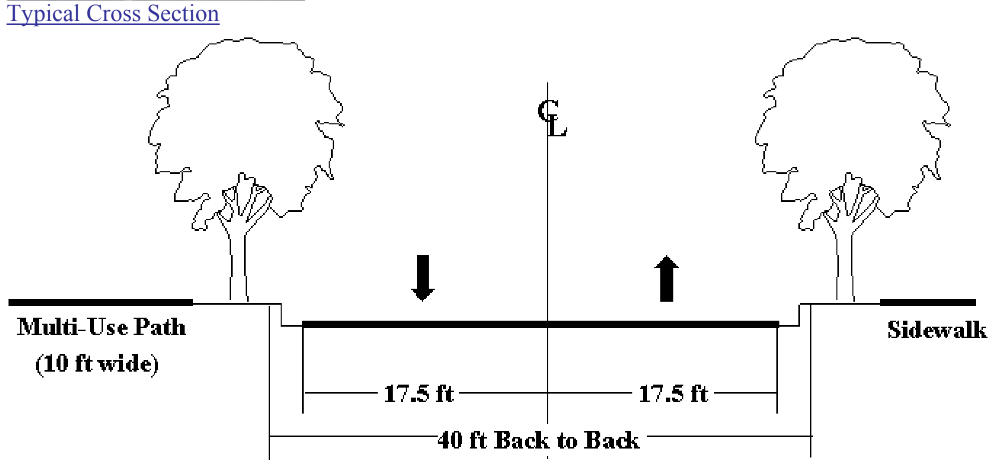
Five Lanes

Durham Road (NC 98) from US 1 Northbound Ramps to Ligon Mill Road Extension

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	40 ft	65 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Major	n/a	18,000
2025	40 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	9,500	18,000

Looking West Toward Southbound US 1 Ramp

Typical Cross Section



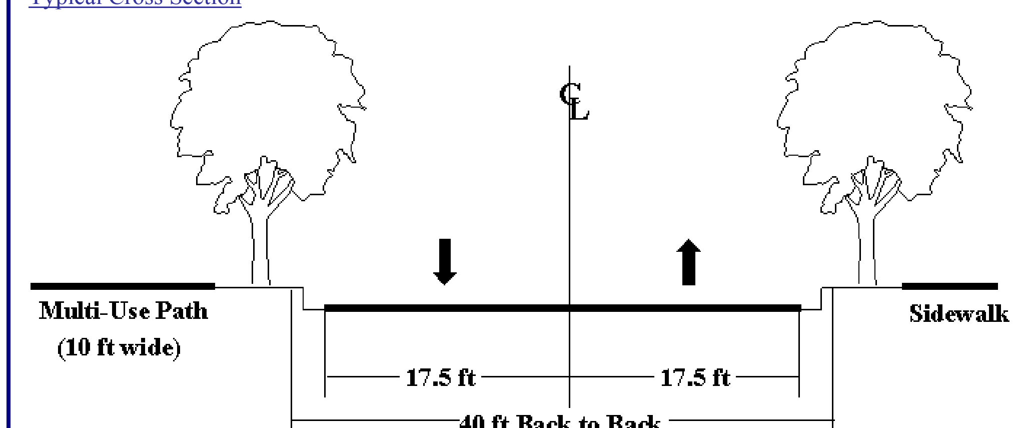
Two Lanes with Left-Turn Lanes

Durham Road (NC 98) from Ligon Mill Road Extension to Tyler Run Drive

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	24 ft	60 ft	2	None	35 mph	Major	n/a	12,000
2025	40 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	3,400	18,000

Looking East Toward Tyler Run Drive

Typical Cross Section



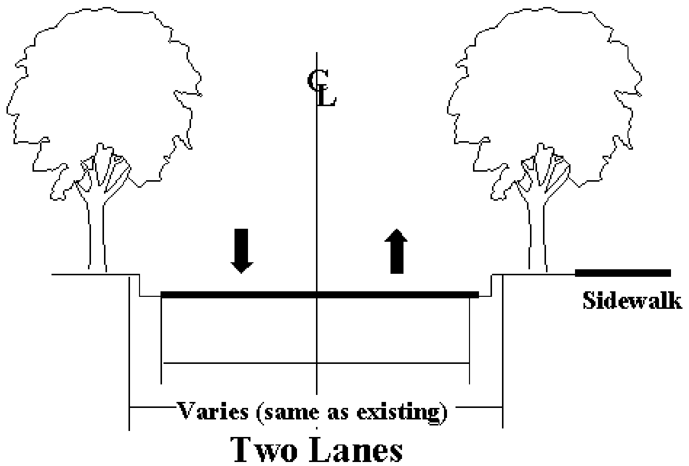
Two Lanes with Left-Turn Lanes

Durham Road (NC 98) from Tyler Run Drive to Wingate Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	28 ft	60 ft	2	None	35 mph	Major	14,200	12,000
2025	28 ft	60 ft	2	None	35 mph	Local-Major	3,400	12,000

Looking West Toward Wingate Street

Typical Cross Section

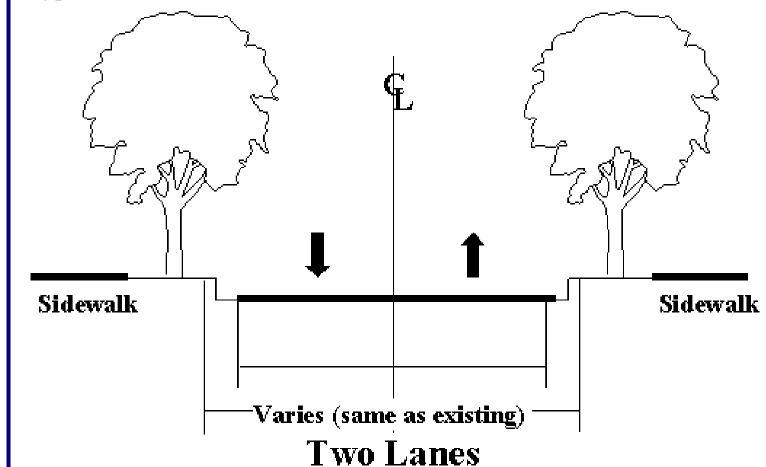


Elm Avenue from South Main Street to White Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	29 ft	50 ft	2	None	25 mph	Major	n/a	17,500
2025	29 ft	50 ft	2	None	25 mph	Minor	1,500	12,000

Looking West Toward South Main Street (US 1A)

Typical Cross Section

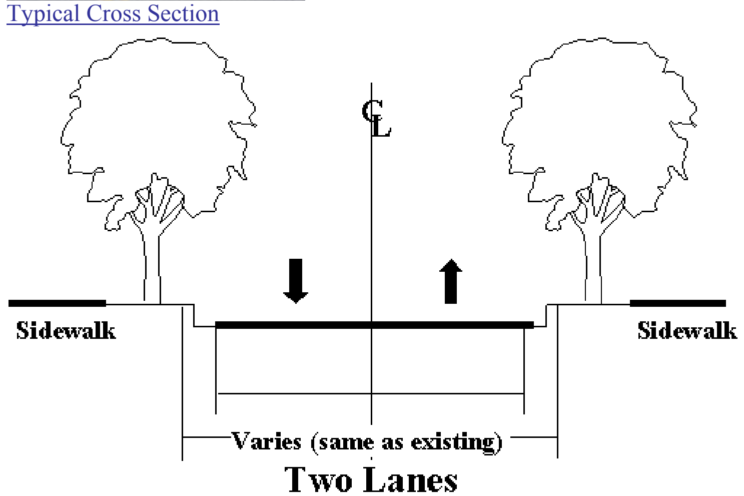


Elm Avenue from White Street to Brooks Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	33 ft	50 ft	2	None	25 mph	Major	n/a	17,500
2025	33 ft	50 ft	2	None	25 mph	Minor	1,500	12,000

Looking West Toward White Street

Typical Cross Section

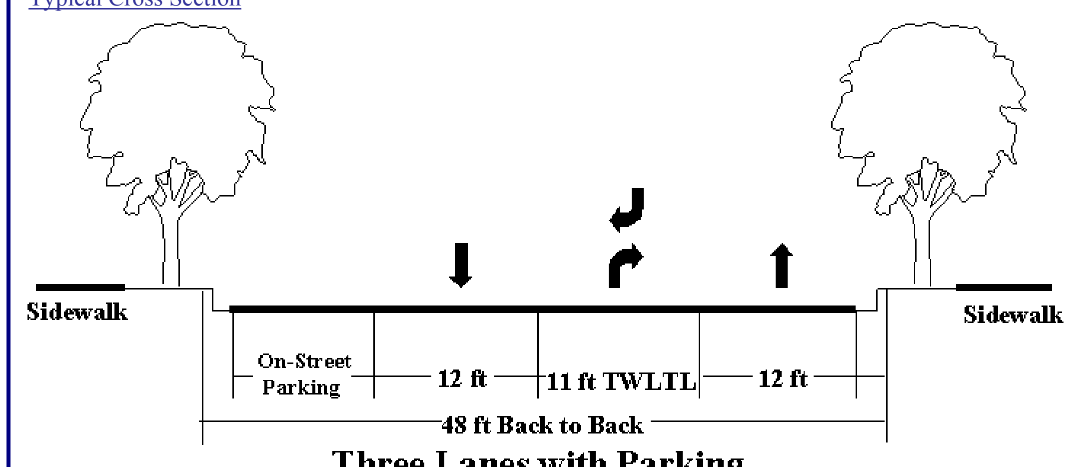


Elm Avenue from Brooks Street to Franklin Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	48 ft	70 ft	4	None	25 mph	Major	n/a	22,000
2025	48 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	25 mph	Minor	1,500	18,000

Looking West Toward White Street

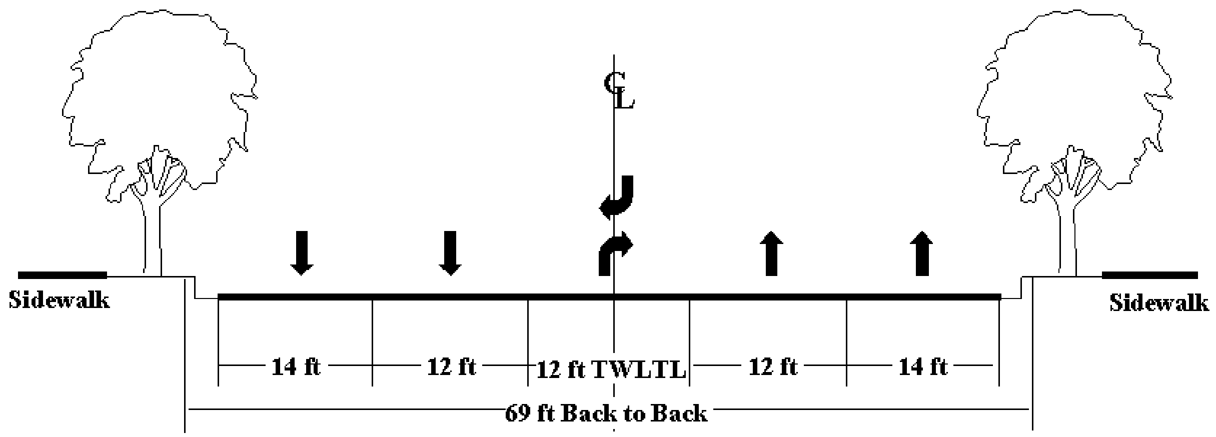
Typical Cross Section



Franklin Street from East Roosevelt Avenue to Holding Avenue

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	69 ft	90 ft	4	Two-way Left-turn Lane	35 mph	Minor	n/a	32,000
2025	69 ft	90 ft	4	Two-way Left-turn Lane	35 mph	Local-Major	2,100	32,000

Typical Cross Section

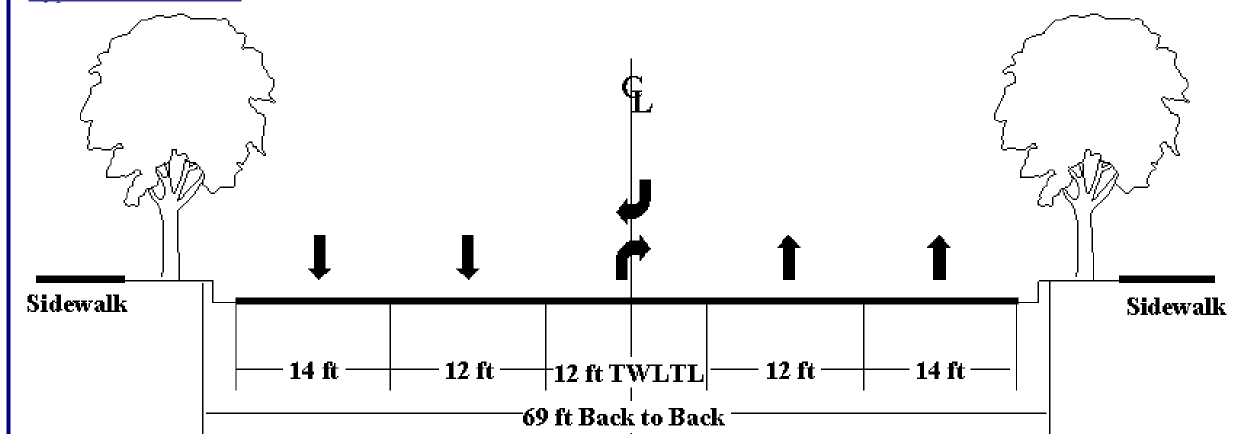


Five Lanes

Franklin Street Extension from Holding Avenue to Rogers Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	0 ft	0	Not Constructed	0 mph	n/a	n/a	0
2025	69 ft	90 ft	4	Two-way Left-turn Lane	35 mph	Local-Major	2,800	32,000

Typical Cross Section



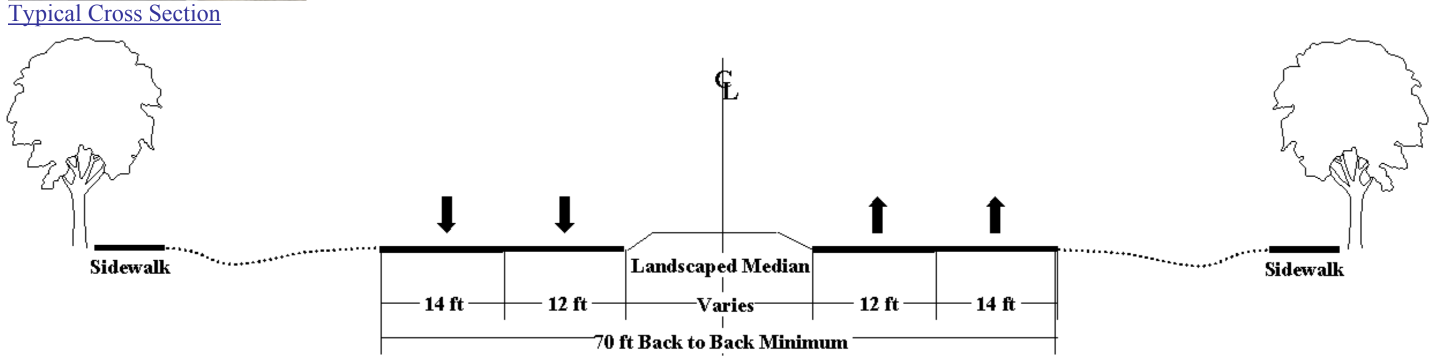
Five Lanes

Forestville Road from Rogers Road to Burlington Mills Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	19 ft	60 ft	2	None	50 mph	Major	n/a	12,000
2025	70 ft	110 ft	4	Landscaped Median	45 mph	Secondary-Major	20,700	38,000

Looking South Toward Burlington Mills Road

Typical Cross Section



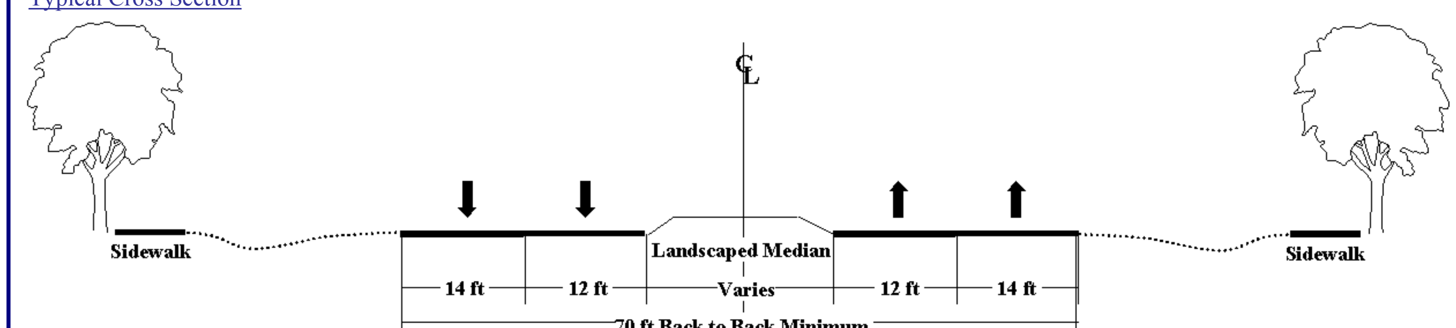
Four Lanes with a Landscaped Median

Forestville Road from Burlington Mills Road to US 401

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	19 ft	60 ft	2	None	45 mph	Major	n/a	12,000
2025	70 ft	110 ft	4	Landscaped Median	45 mph	Secondary-Major	16,500	38,000

Looking South Toward Lillie Liles Road

Typical Cross Section

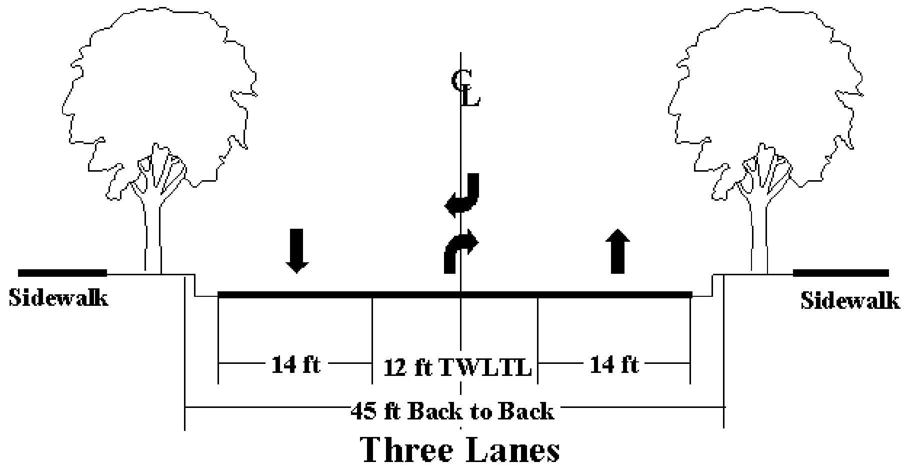


Four Lanes with a Landscaped Median

Heritage Lake Road from the Planned NC 98 Bypass to Rogers Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	0 ft	0	Not Constructed	0 mph	n/a	n/a	0
2025	45 ft	90 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	16,000	18,000

Typical Cross Section

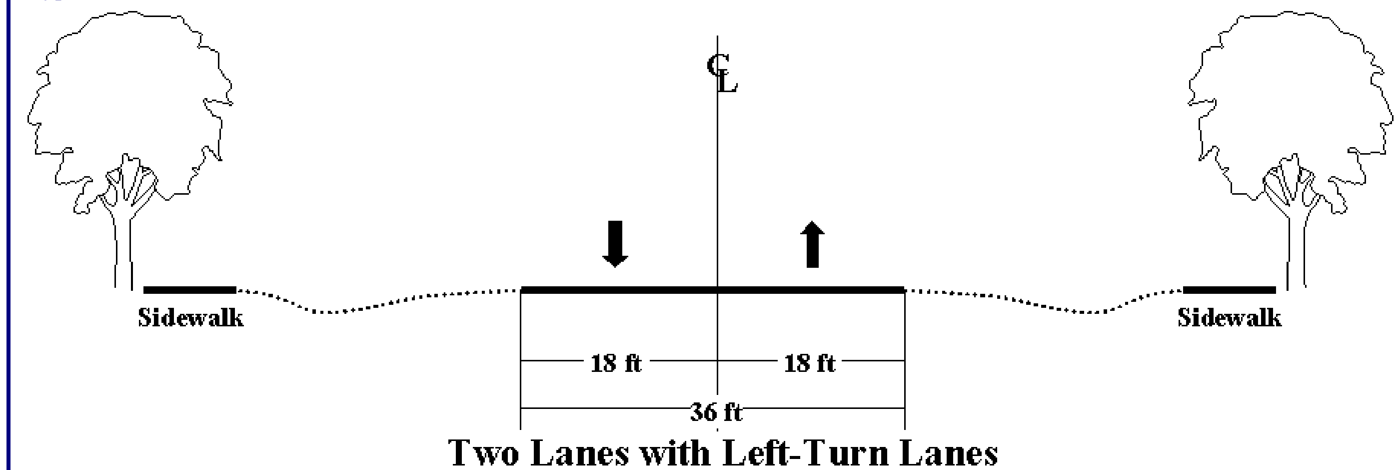


Harris Road from Capital Boulevard (US 1) to Oak Avenue/Wall Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	60 ft	2	None	45 mph	Major	2,100	12,000
2025	36 ft	90 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Local-Major	11,000	18,000

Looking West Toward Capital Boulevard (US 1)

Typical Cross Section

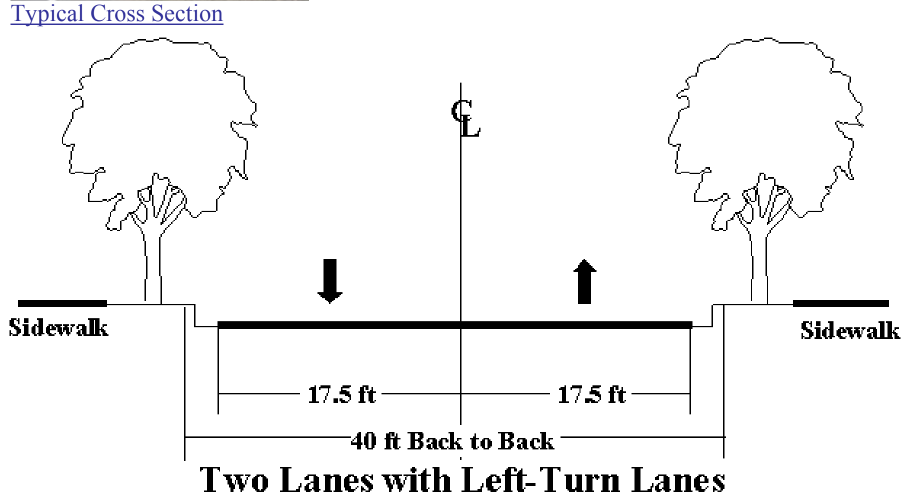


Harris Road from Oak Avenue/Wall Road to North Main Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	27 ft	90 ft	2	None	45 mph	Major	n/a	17,500
2025	40 ft	90 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Local-Major	9,600	18,000

Looking West Toward Wall Road/Oak Avenue

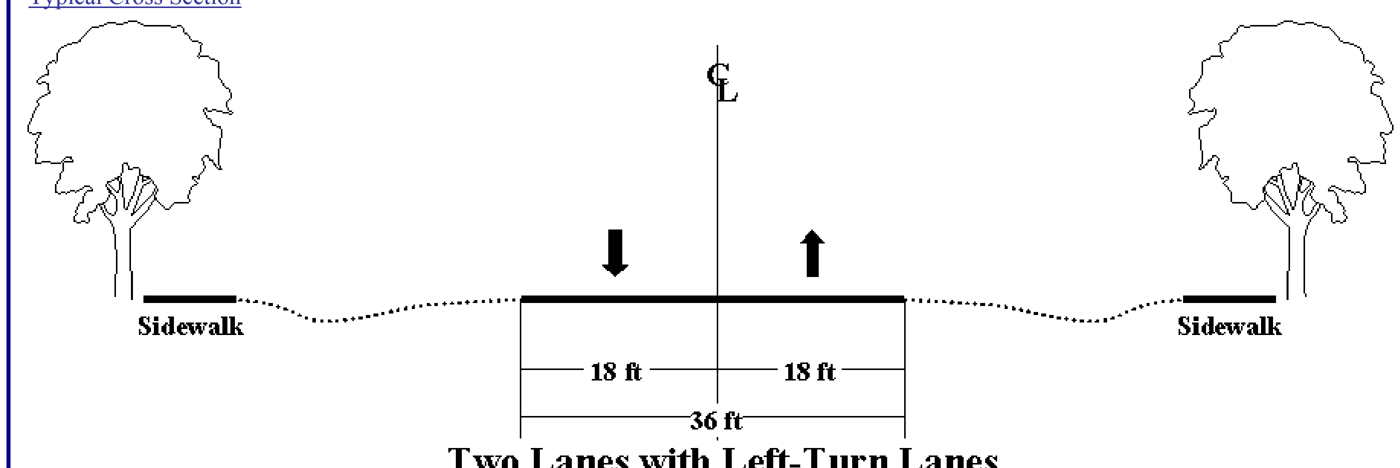
Typical Cross Section



Planned North Loop from North Main Street to Oak Grove Church Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	0 ft	0	Not Constructed	0 mph	n/a	n/a	0
2025	36 ft	90 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Local-Major	10,200	18,000

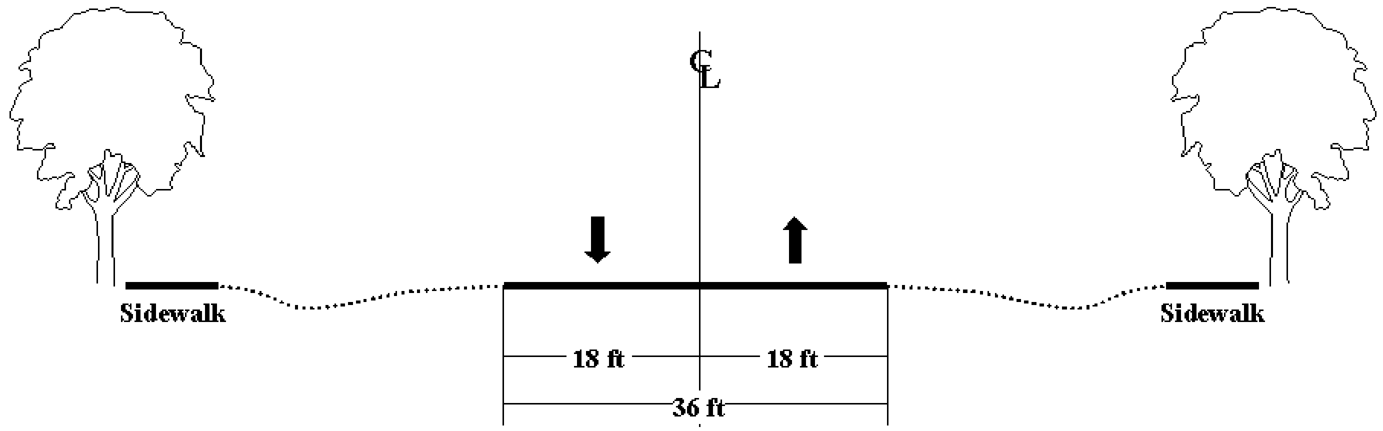
Typical Cross Section



Planned North Loop from Oak Grove Chruch Road to East Wait Avenue (NC 98)

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	0 ft	0	Not Constructed	0 mph	n/a	n/a	0
2025	36 ft	90 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Local-Major	9,100	18,000

Typical Cross Section



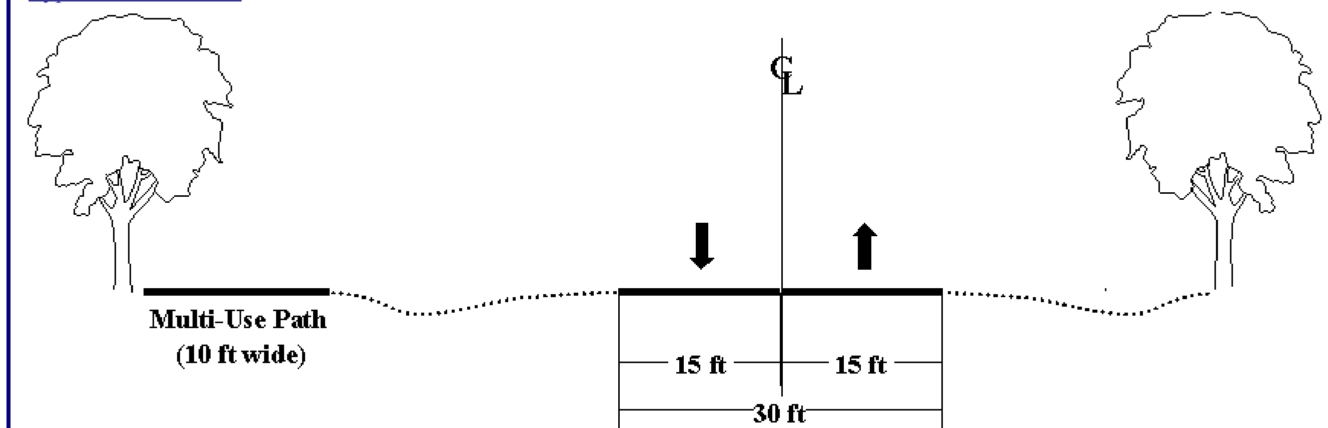
Two Lanes with Left-Turn Lanes

Jenkins Road from Thompson Mill Road to Capital Boulevard (US 1)

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	60 ft	2	None	45 mph	Major	3,300	12,000
2025	30 ft	70 ft	2	None	45 mph	Local-Major	3,300	12,000


Looking West Toward Thompson Mill Road

Typical Cross Section



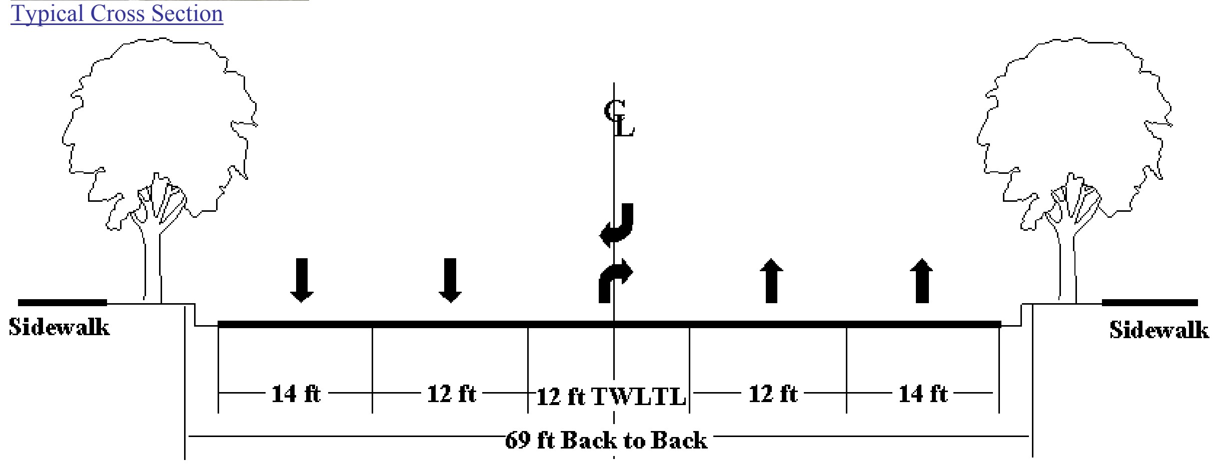
Two Lanes

Jones Dairy Road from East Wait Avenue (NC 98) to Averette Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	19 ft	60 ft	2	None	50 mph	Major	5,500	12,000
2025	69 ft	90 ft	4	Two-way Left-turn Lane	45 mph	Local-Major	14,100	32,000


Looking South Toward Averette Road

Typical Cross Section



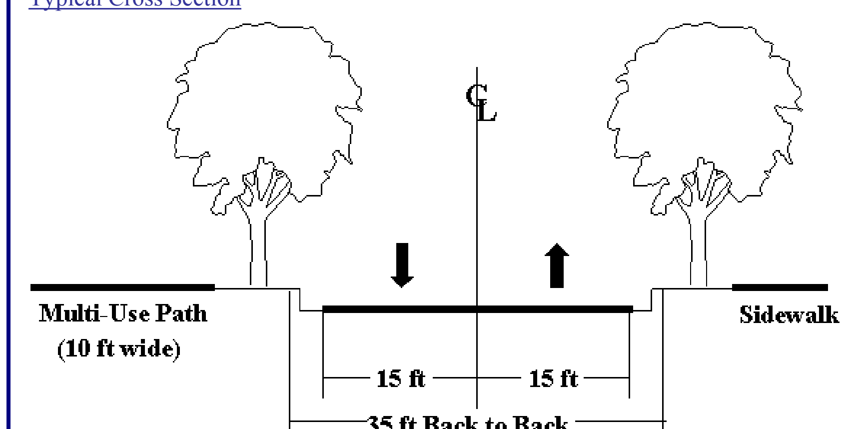
Five Lanes

Juniper Avenue from White Street to North Allen Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	20 ft	50 ft	2	None	35 mph	Major	1,700	12,000
2025	35 ft	60 ft	2	None	35 mph	Local-Major	1,700	12,000


Looking West Toward White Street

Typical Cross Section



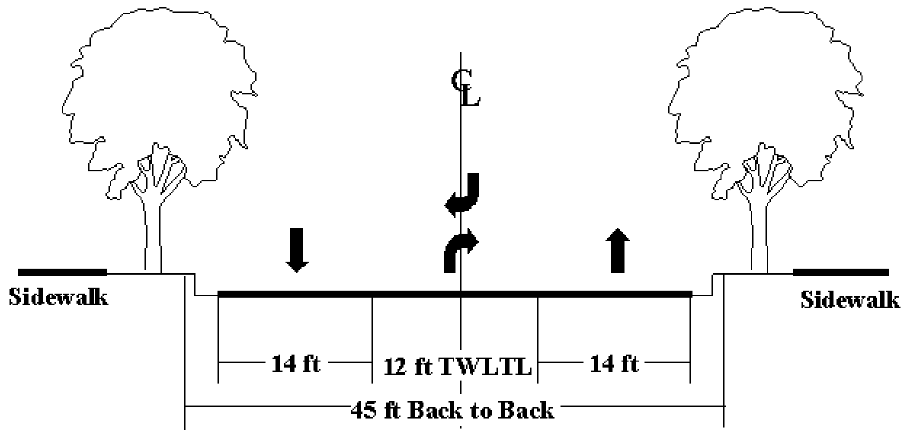
Two Lanes

Ligon Mill Road Extension from Wake Union Church Rd Ext. to Durham Road (NC 98)

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	0 ft	0	Not Constructed	0 mph	n/a	n/a	0
2025	45 ft	90 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	4,200	18,000

Subject to revision based on adjacent development.

Typical Cross Section

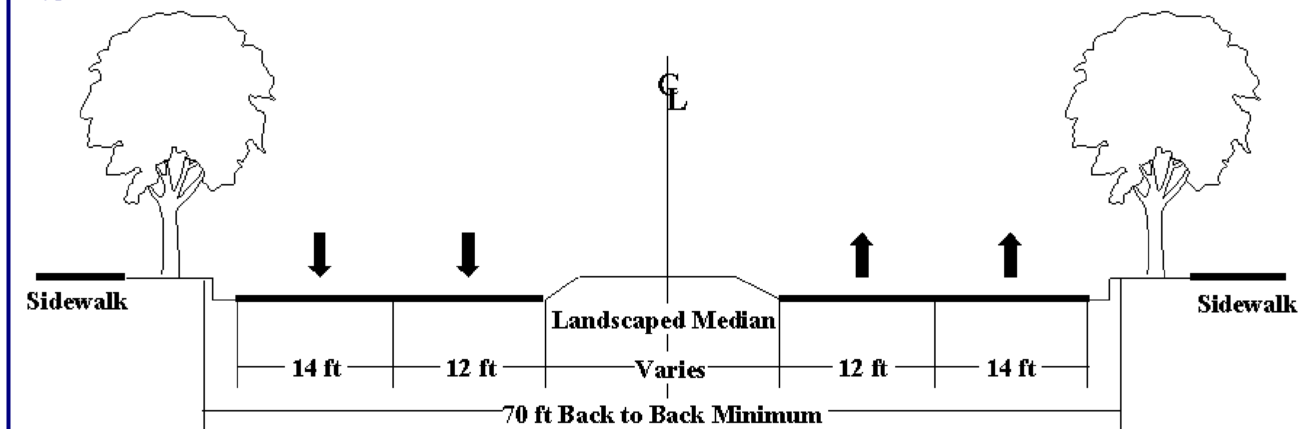


Three Lanes

Ligon Mill Road Extension from Durham Road (NC 98) to South Main Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	0 ft	0	Not Constructed	0 mph	n/a	n/a	0
2025	70 ft	90 ft	4	Landscaped Median	35 mph	Local-Major	2,600	38,000

Typical Cross Section



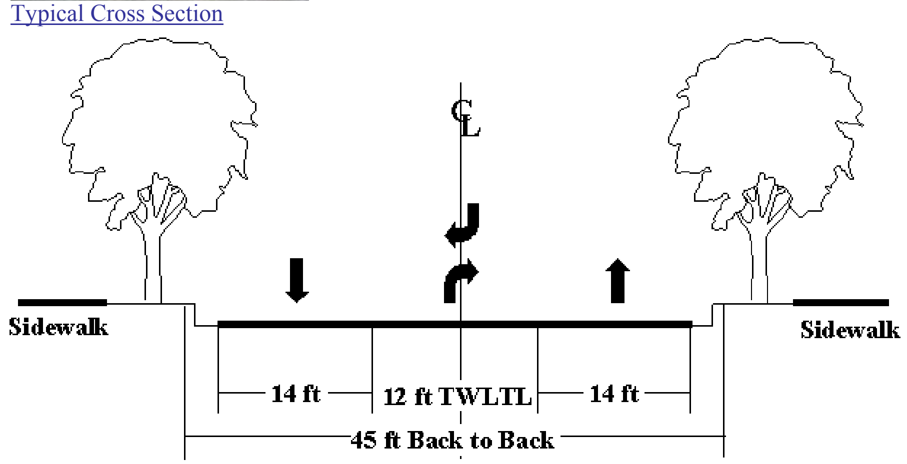
Four-Lanes with a Landscaped Median

Ligon Mill Road from South Main Street to Burlington Mills Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	20 ft	60 ft	2	None	35 mph	Major	2,100	12,000
2025	45 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Local-Major	10,000	18,000

Looking South Toward Burlington Mills Road

Typical Cross Section



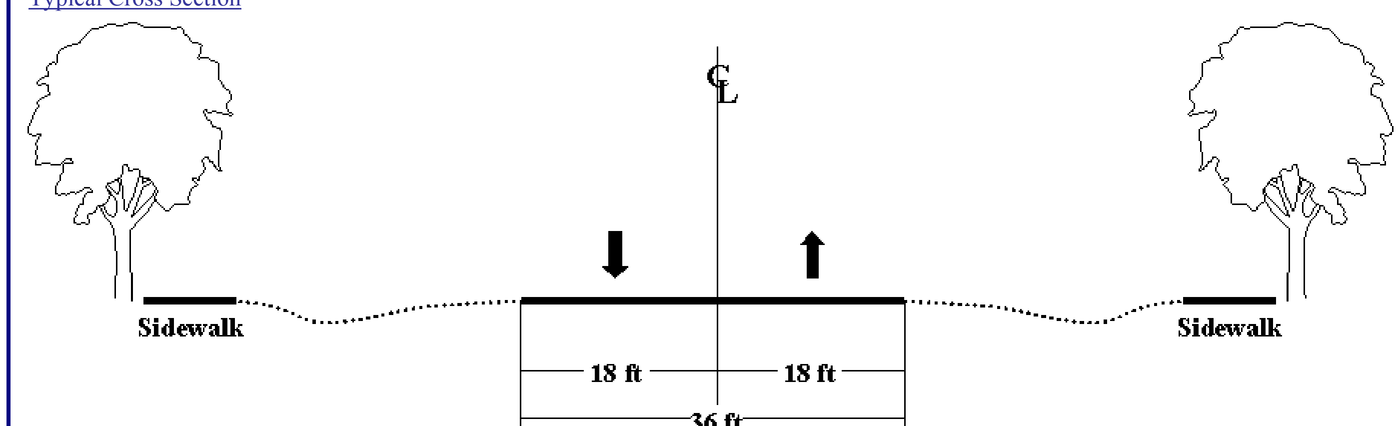
Three Lanes

Ligon Mill Road from Burlington Mills Road to US 401

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	60 ft	2	None	45 mph	Major	n/a	12,000
2025	36 ft	90 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Local-Major	10,000	18,000

Looking South Toward Burlington Mills Road

Typical Cross Section



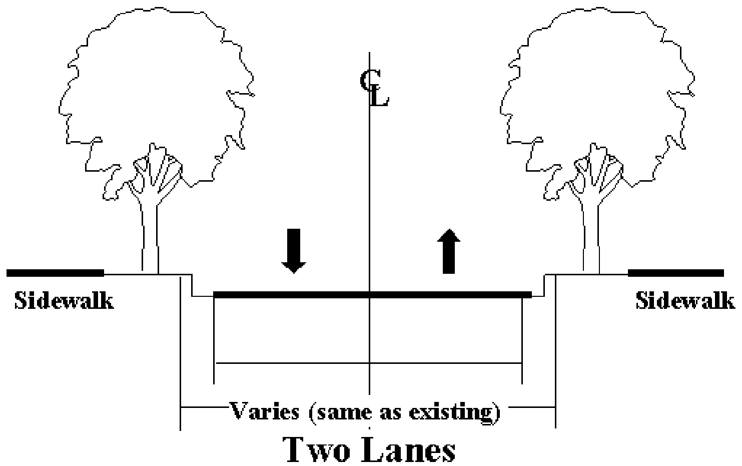
Two Lanes with Left-Turn Lanes

North Avenue from Wingate Street to North Main Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	30 ft	60 ft	2	None	25 mph	Major	n/a	17,500
2025	30 ft	60 ft	2	None	25 mph	Local-Major	2,400	12,000

Looking East Toward North Main Street (US 1A)

Typical Cross Section

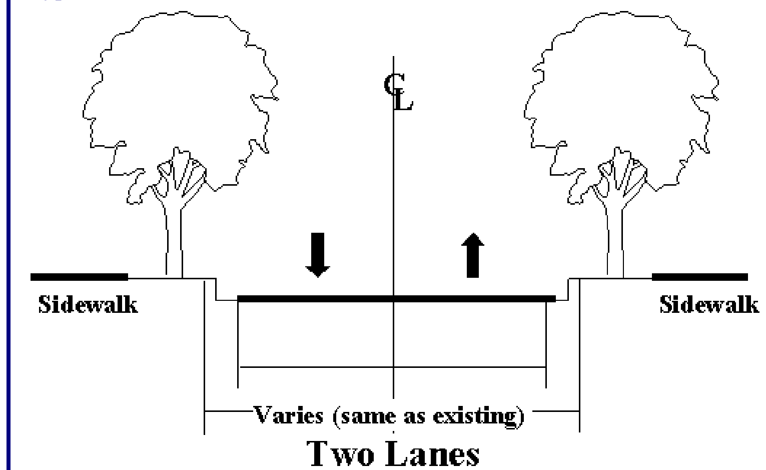


Front Street (NC 98) from North Main Street to South Main Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	30 ft	50 ft	2	None	25 mph	Major	13,000	17,500
2025	30 ft	50 ft	2	None	25 mph	Local-Major	2,400	12,000

Looking North Toward North Avenue

Typical Cross Section

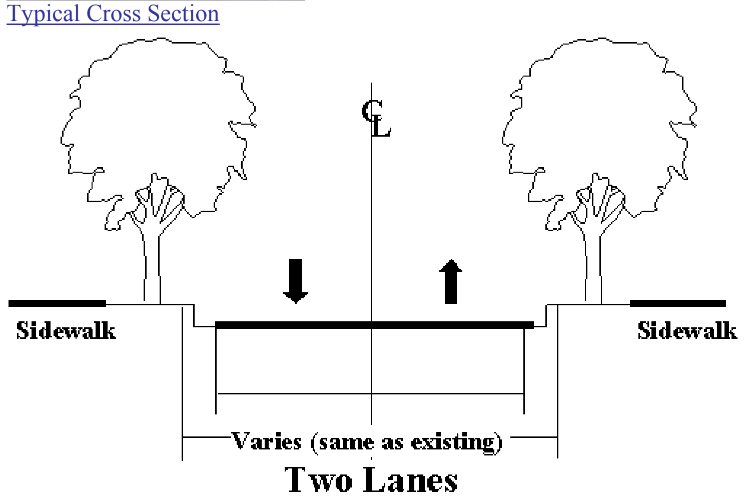


South Avenue (NC 98) from Wingate Street to South Main Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	41 ft	60 ft	2	None	25 mph	Major	14,200	17,500
2025	41 ft	60 ft	2	None	25 mph	Local-Major	2,400	12,000

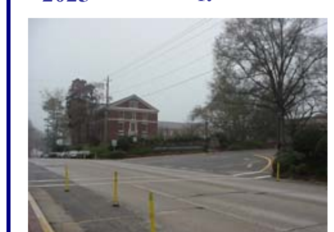
Looking West Toward Wingate Street

Typical Cross Section



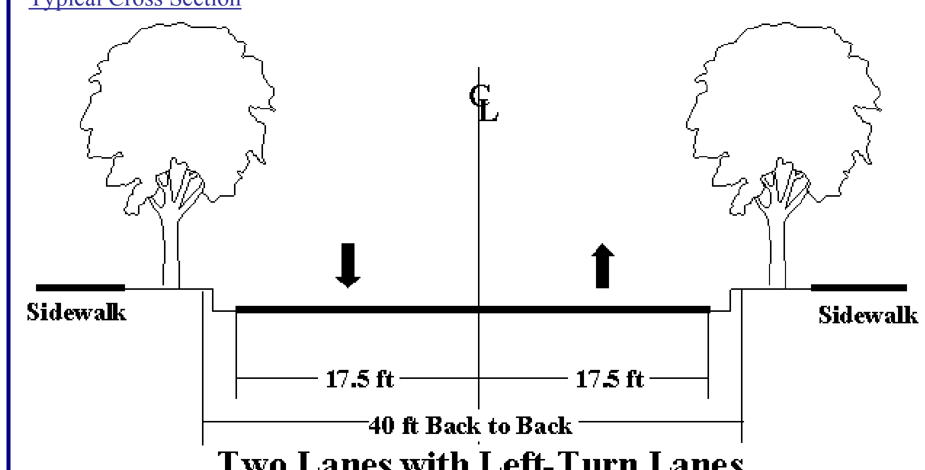
New Wingate Street from North Avenue to South Avenue

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	0 ft	0	Not Constructed	0 mph	n/a	n/a	0
2025	40 ft	60 ft	2	Left-turn Lanes at Intersections and Driveways	25 mph	Local-Major	1,000	18,000



Looking North Toward North Avenue

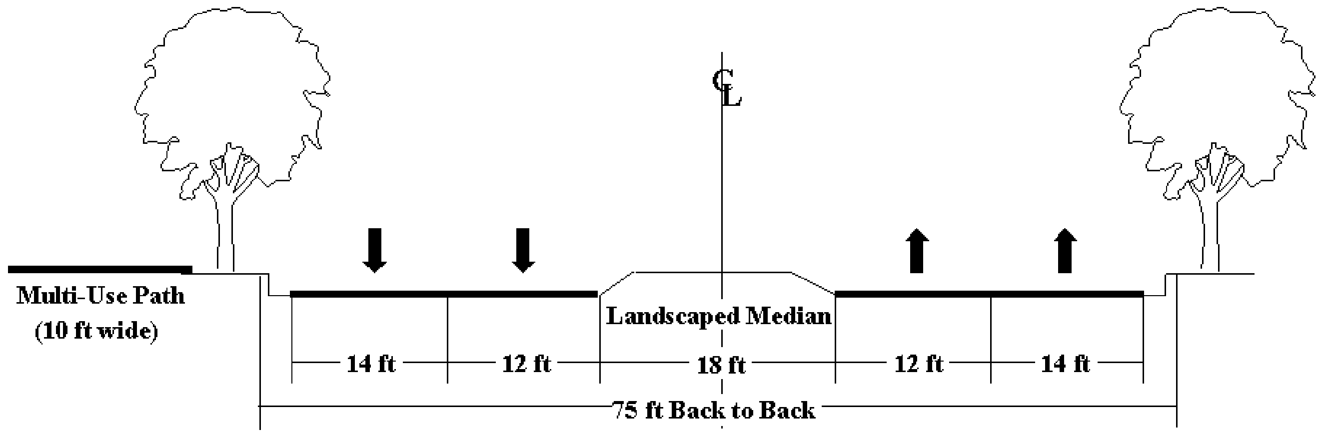
Typical Cross Section



NC 98 Bypass from Durham Road (NC 98) to Capital Boulevard (US 1)

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	0 ft	0	Not Constructed	0 mph	n/a	n/a	0
2025	75 ft	150 ft	4	Landscaped Median	45 mph	Primary-Major	23,500	38,000

Typical Cross Section

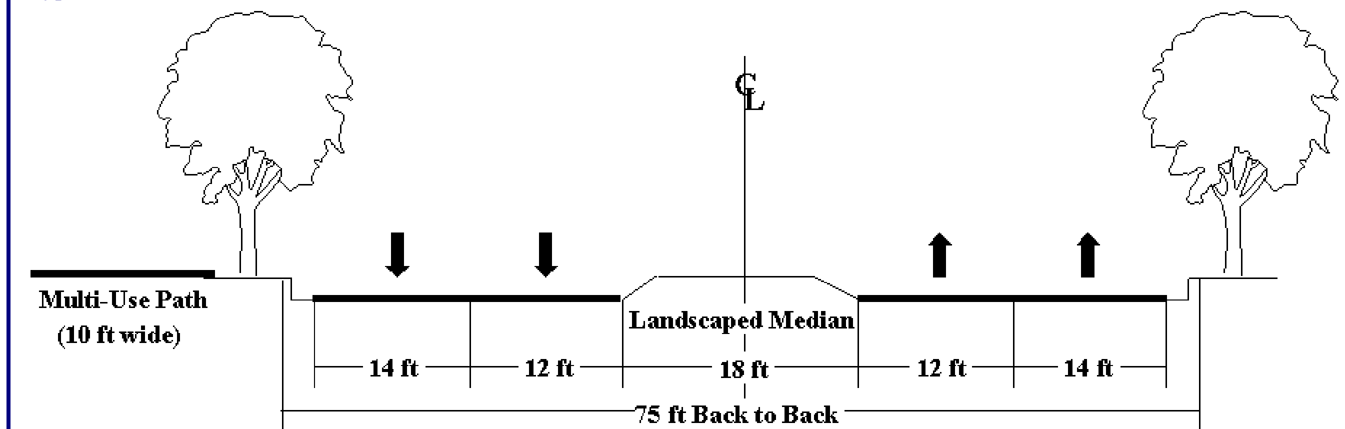


Four Lanes with a Landscaped Median

NC 98 Bypass from Capital Boulevard (US 1) to South Main Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	0 ft	0	Not Constructed	0 mph	n/a	n/a	0
2025	75 ft	150 ft	4	Landscaped Median	45 mph	Primary-Major	28,400	38,000

Typical Cross Section

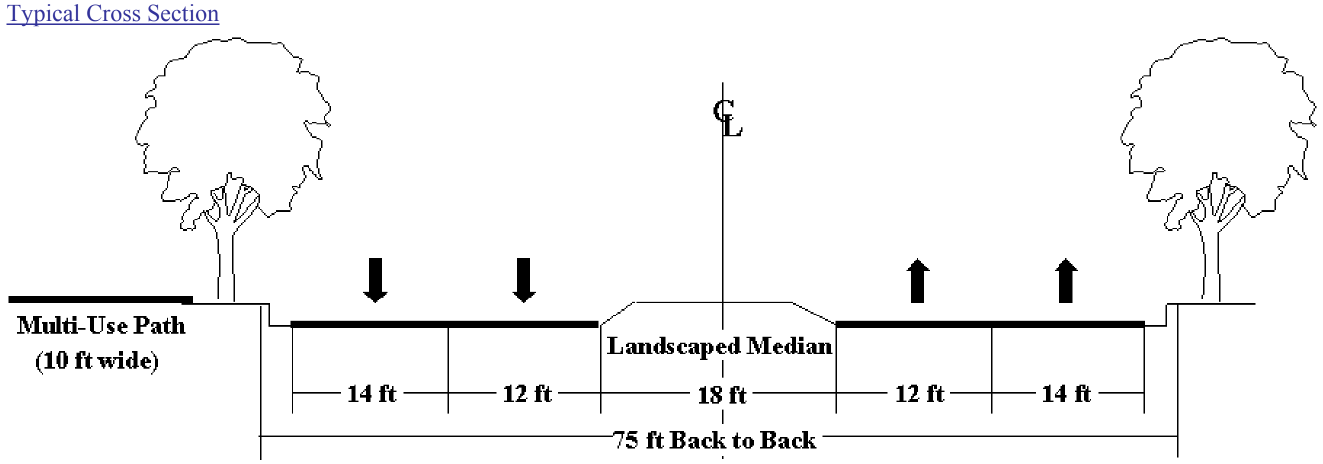


Four Lanes with a Landscaped Median

NC 98 Bypass from South Main Street to East Wait Avenue

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	n/a ft	0 ft	0	Not Constructed	0 mph	n/a	n/a	0
2025	75 ft	150 ft	4	Landscaped Median	45 mph	Primary-Major	24,000	38,000

Typical Cross Section



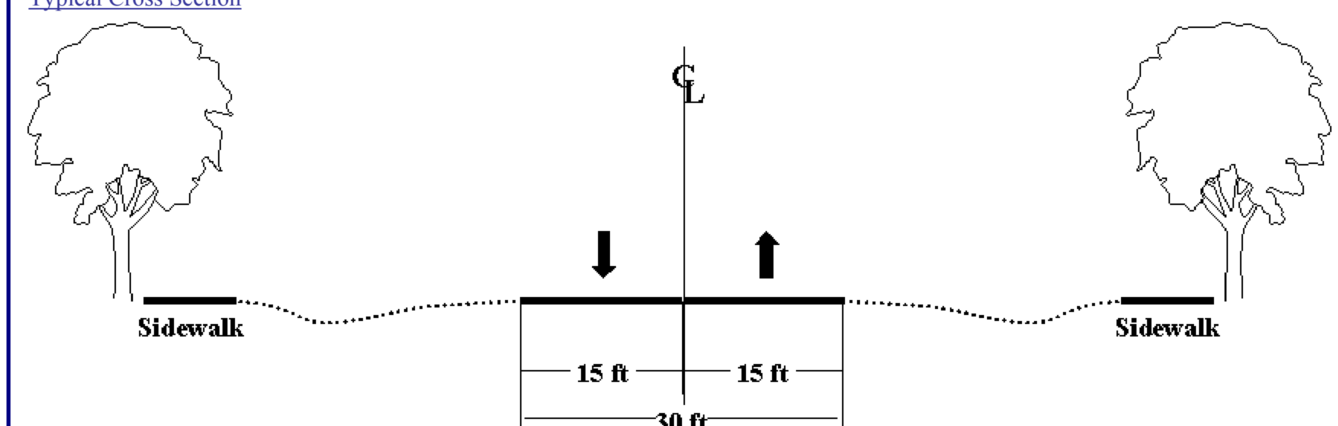
Four Lanes with a Landscaped Median

North Main Street from Wake County Line to Oak Avenue

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	22 ft	100 ft	2	None	45 mph	Major	2,400	12,000
2025	30 ft	100 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Local-Major	2,400	18,000

Looking South Toward Oak Street

Typical Cross Section



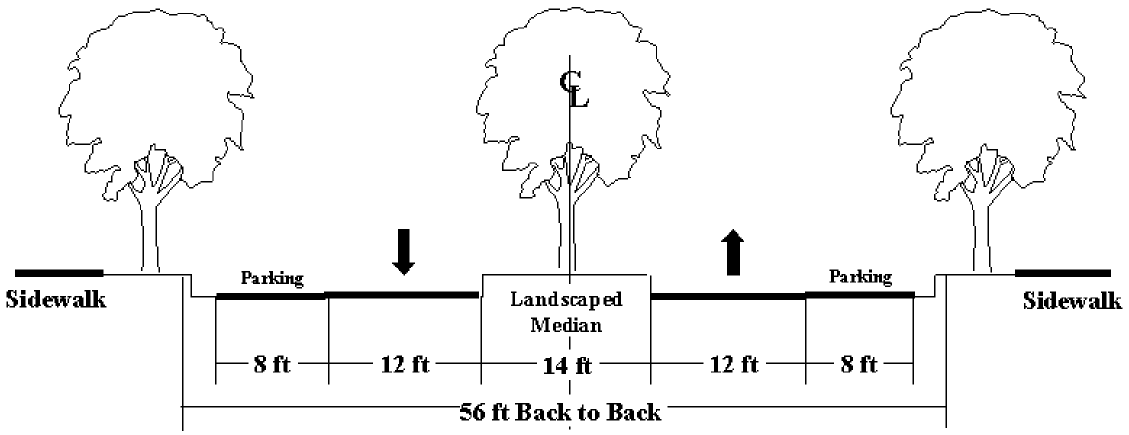
Two Lanes

North Main Street from Oak Avenue to Cedar Avenue

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	28 ft	60 ft	2	None	35 mph	Major	n/a	17,500
2025	56 ft	85 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	2,700	18,000

Looking North Toward Oak Avenue

Typical Cross Section



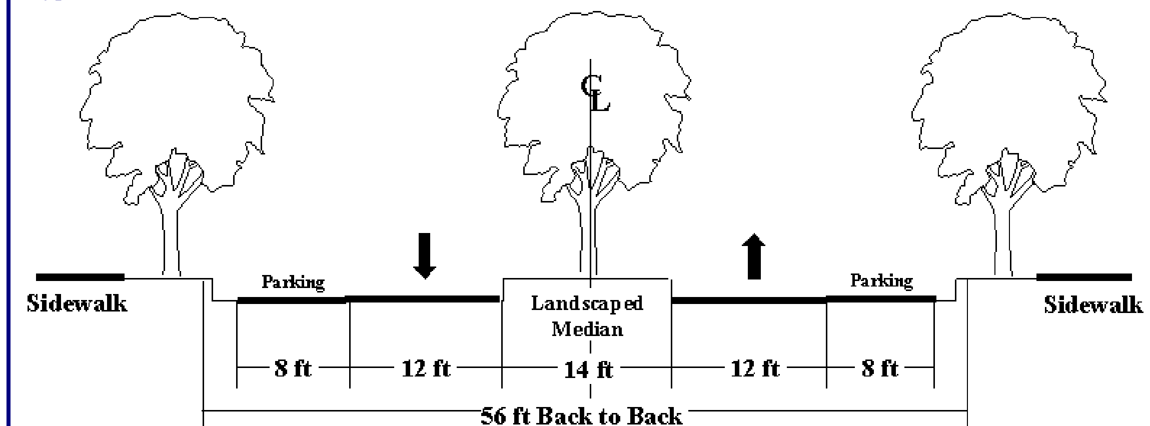
Two Lanes with a Landscaped Median

North Main Street from Cedar Avenue to North Avenue

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	53 ft	85 ft	2	None	25 mph	Major	5,800	17,500
2025	56 ft	85 ft	2	None	35 mph	Local-Major	5,800	17,500

Looking South Toward North Avenue

Typical Cross Section



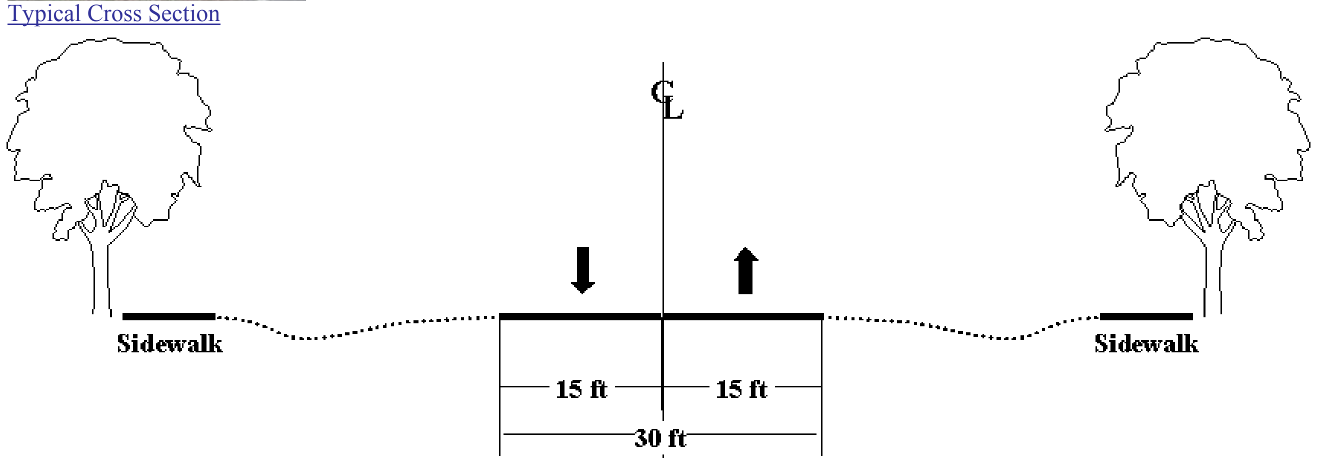
Two Lanes with a Landscaped Median

Oak Avenue/Wall Rd from Capital Boulevard (US 1) to Remington Woods Drive

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	65 ft	2	None	35 mph	Major	n/a	12,000
2025	30 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	1,400	18,000

Looking West Toward Harris Road

Typical Cross Section



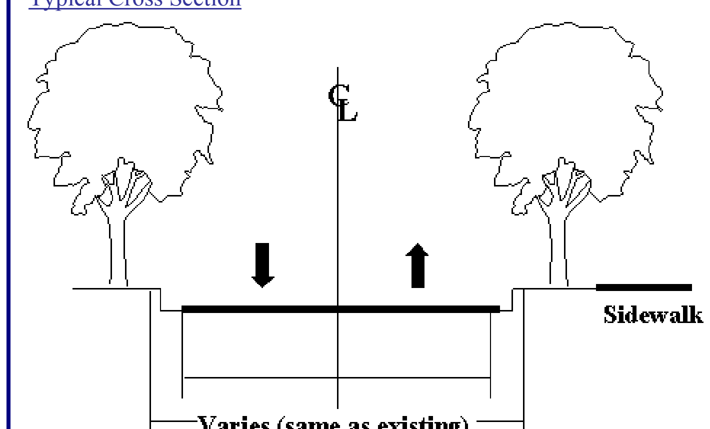
Two Lanes

Oak Avenue from Remington Woods Drive to Wingate Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	41 ft	65 ft	2	None	35 mph	Major	n/a	17,500
2025	41 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	1,400	18,000

Looking East Toward Wingate Street

Typical Cross Section



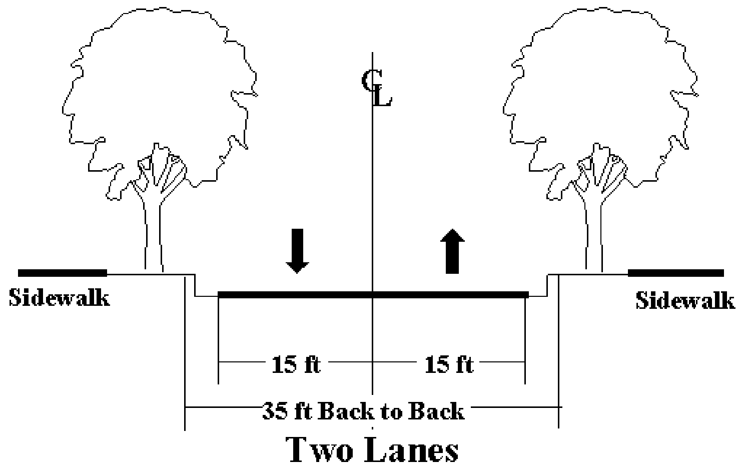
Two Lanes

Oak Avenue from Wingate Street to North Main Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	19 ft	60 ft	2	None	35 mph	Major	2,400	12,000
2025	35 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	1,400	18,000

Looking West Toward Wingate Street

Typical Cross Section

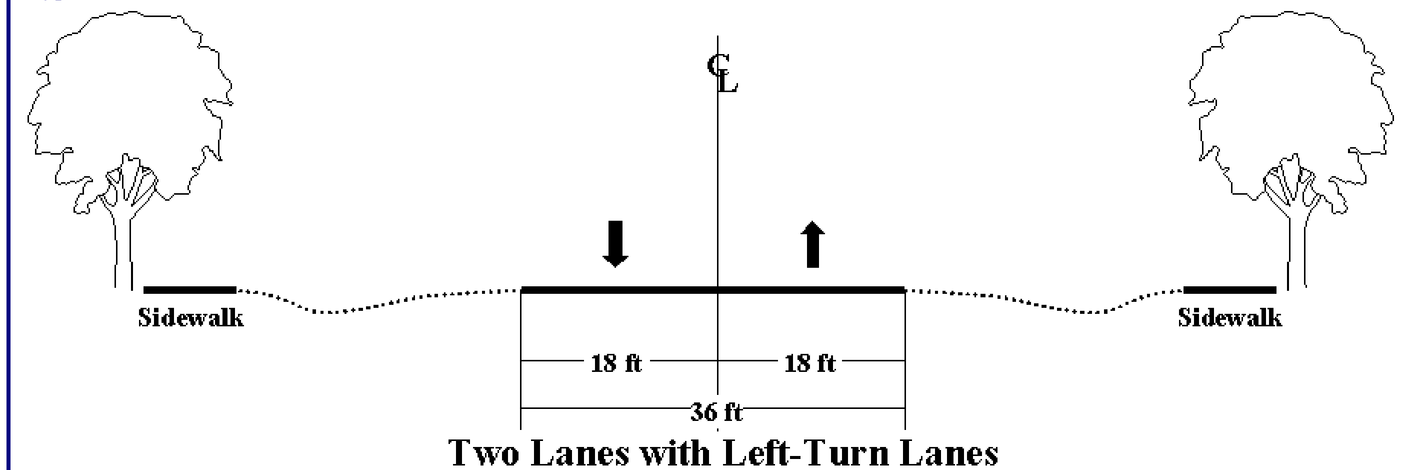


Oak Grove Church Road from North Allen Road to Averette Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	60 ft	2	None	45 mph	Major	n/a	12,000
2025	36 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	1,700	18,000

Looking West Toward Jubilee Court

Typical Cross Section

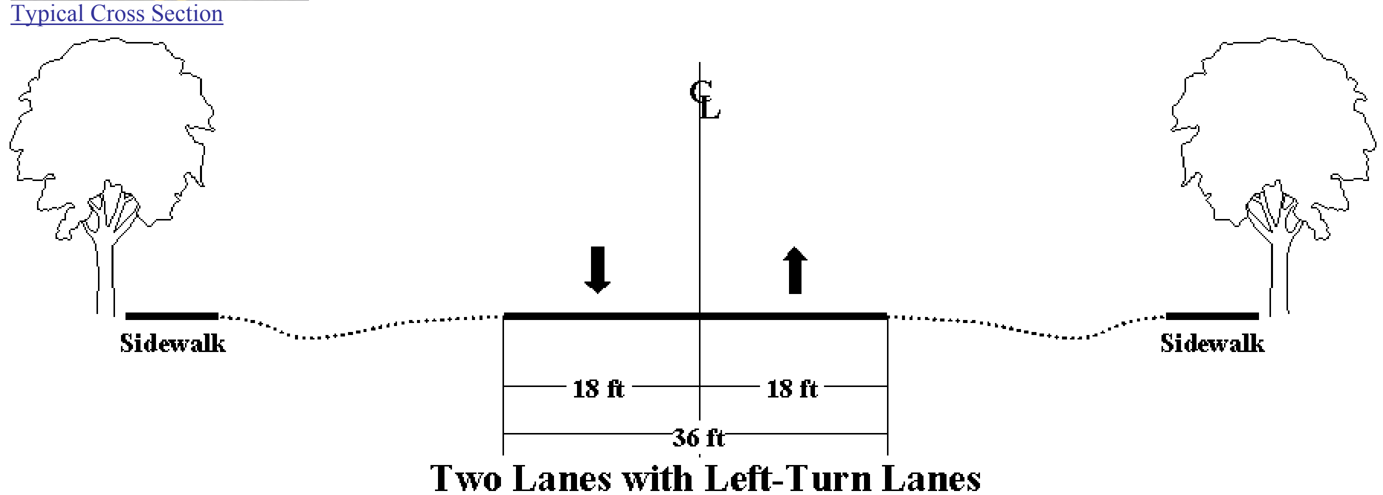


Oak Grove Church Road from Averette Road to NC 96

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	60 ft	2	None	45 mph	Major	n/a	12,000
2025	36 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	1,700	18,000

Looking West Toward Averette Road

Typical Cross Section

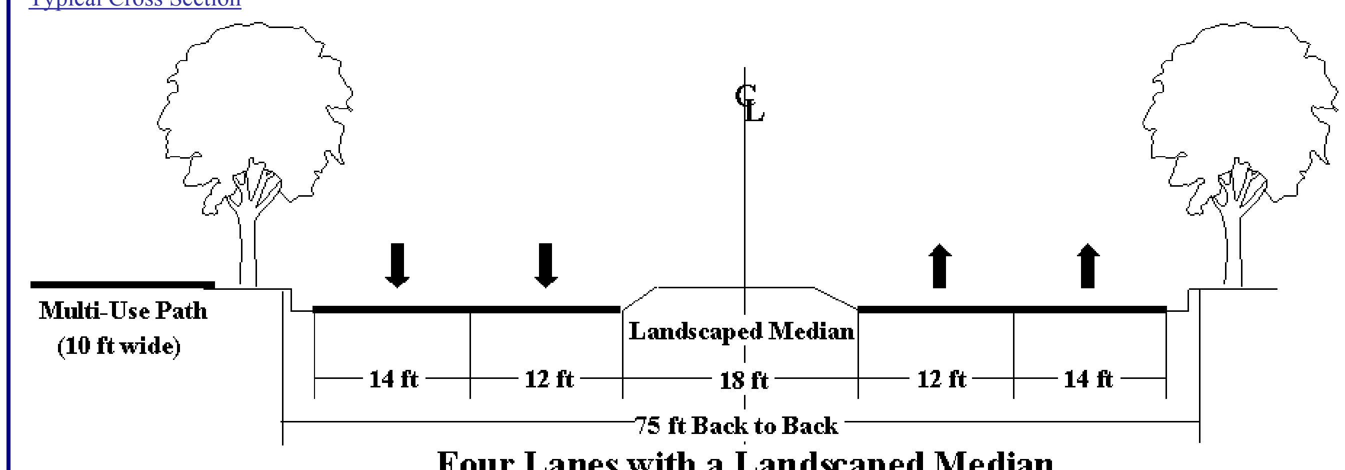


Old NC 98 from Falls of the Neuse Road to Durham Road (NC 98)

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	22 ft	60 ft	2	None	45 mph	Major	5,500	12,000
2025	75 ft	100 ft	4	Landscaped Median	45 mph	Secondary-Major	5,200	38,000

Looking North Toward Durham Road (NC 98)

Typical Cross Section

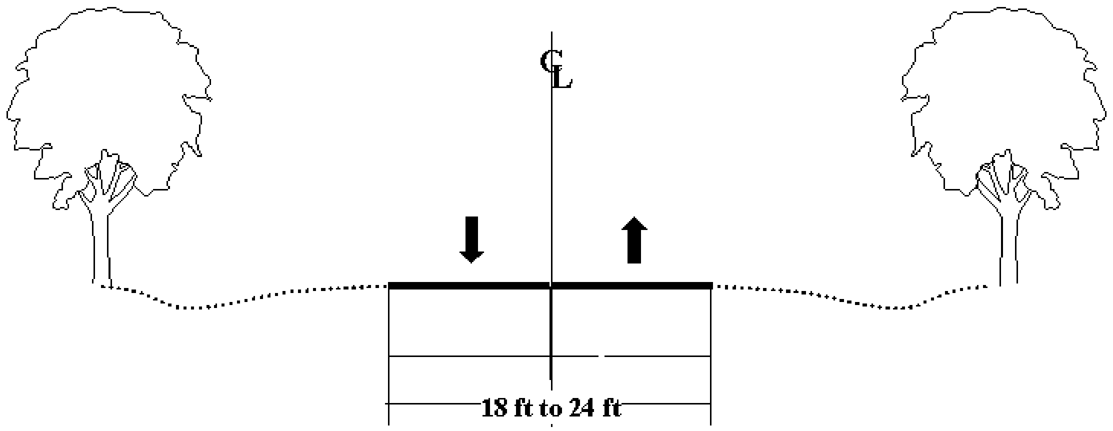


Purnell Road from Bud Smith Road to Capital Boulevard (US 1)

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	22 ft	60 ft	2	None	45 mph	Major	n/a	17,500
2025	22 ft	60 ft	2	None	45 mph	Local-Major	12,600	12,000

Looking East Toward Capital Boulevard (US 1)

Typical Cross Section



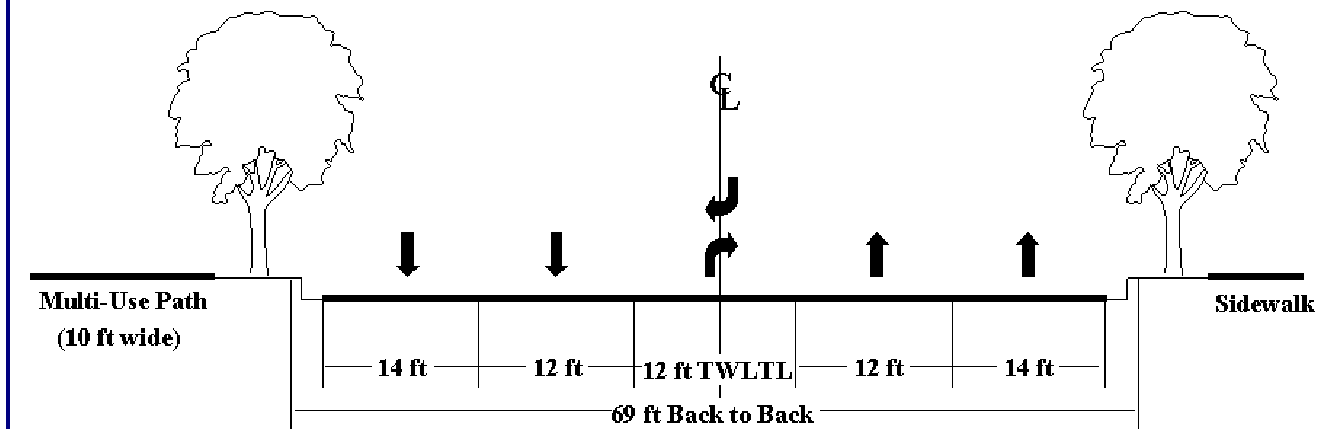
Two Lanes

Rogers Road from South Main Street to 3500' East of Forestville Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	65 ft	90 ft	2	Two-way Left-turn Lane	45 mph	Major	n/a	18,000
2025	69 ft	90 ft	4	Two-way Left-turn Lane	35 mph	Secondary-Major	24,000	32,000

Looking West Toward South Main Street (US 1A)

Typical Cross Section



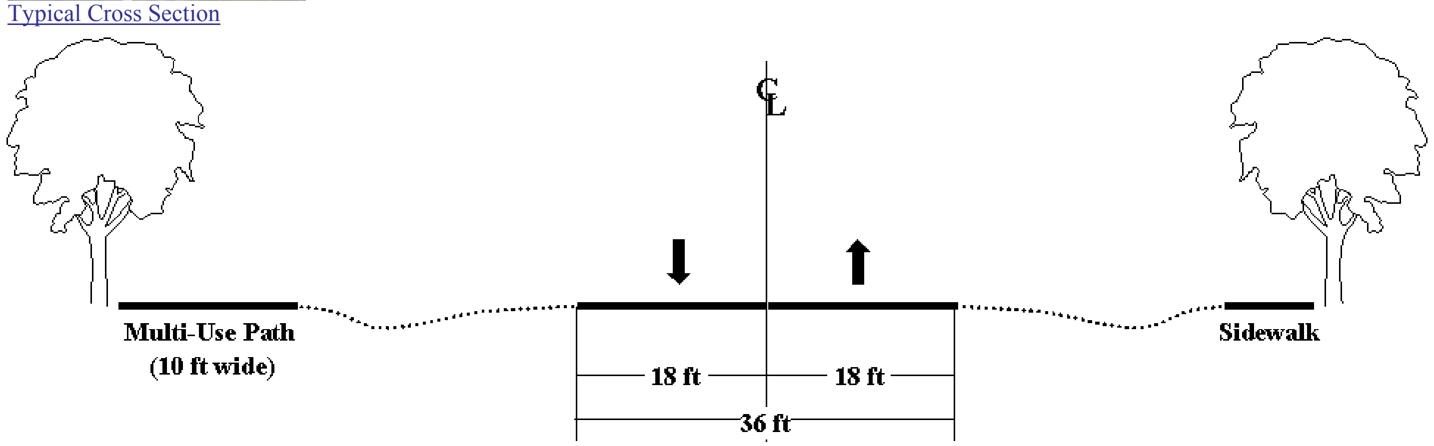
Five Lanes

Rogers Road from 3500' East of Forestville Road to Jeffreys Lane

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	19 ft	60 ft	2	None	45 mph	Major	n/a	12,000
2025	36 ft	90 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Secondary-Major	10,000	18,000

Looking North Toward Forestville Road

Typical Cross Section



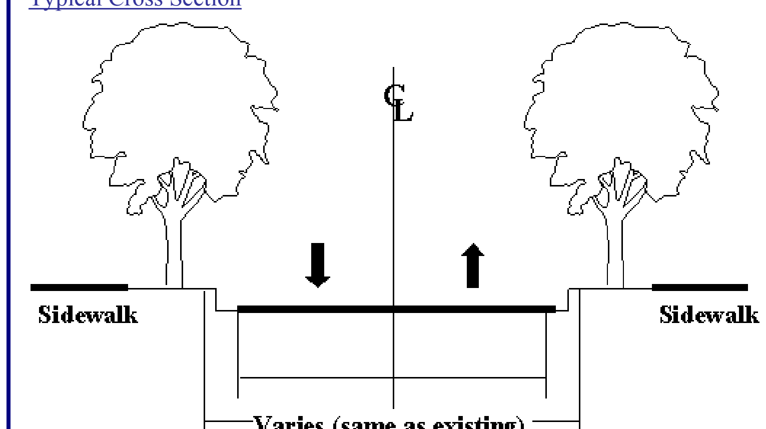
Two Lanes with Left-Turn Lanes

Roosevelt Avenue/Wait Avenue (NC 98) from Front Street to Allen Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	35 ft	45 ft	2	Two-way Left-turn Lane	35 mph	Major	17,500	18,000
2025	35 ft	50 ft	2	None	25 mph	Local-Major	5,000	12,000

Looking West Toward Front Street

Typical Cross Section



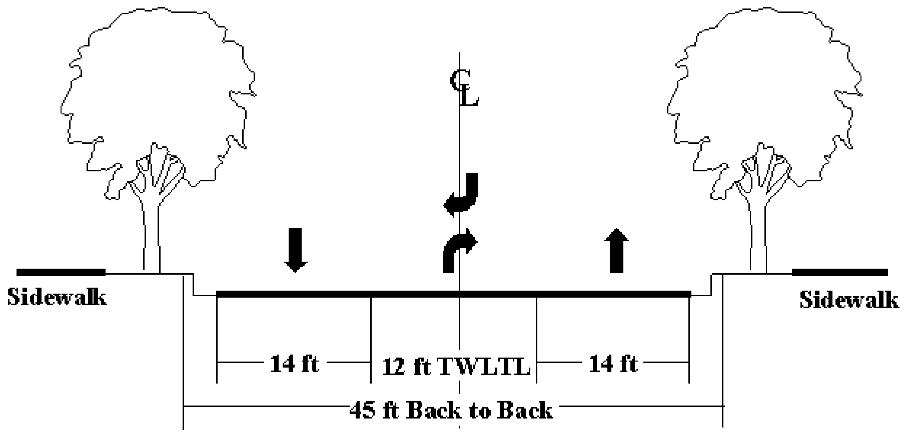
Two Lanes

East Wait Avenue (NC 98) from Allen Road to Jones Dairy Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	24 ft	60 ft	2	None	35 mph	Major	14,200	17,500
2025	45 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	11,500	18,000

Looking West Toward Allen Road

Typical Cross Section



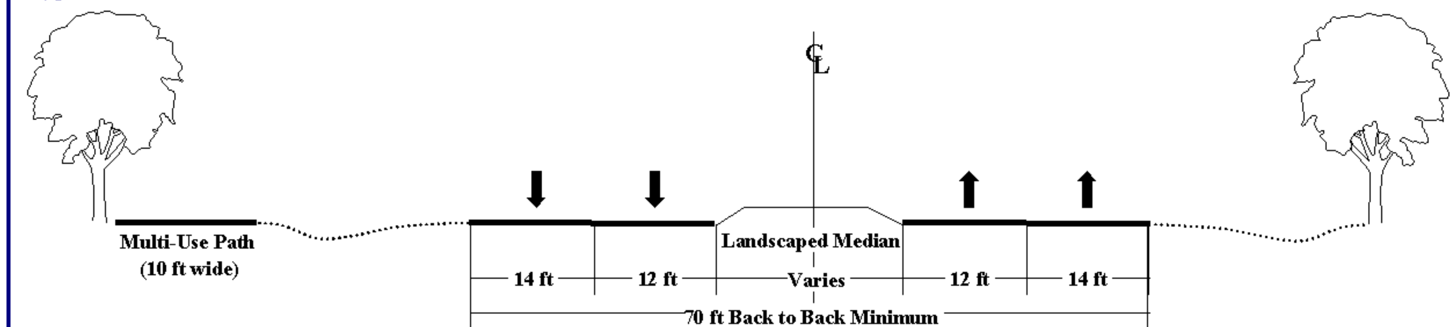
Three Lanes

East Wait Avenue (NC 98) from Jones Dairy Road to NC 96

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	20 ft	60 ft	2	None	35 mph	Major	8,400	12,000
2025	70 ft	110 ft	4	Landscaped Median	45 mph	Primary-Major	17,500	38,000

Looking East Toward Averette Road

Typical Cross Section



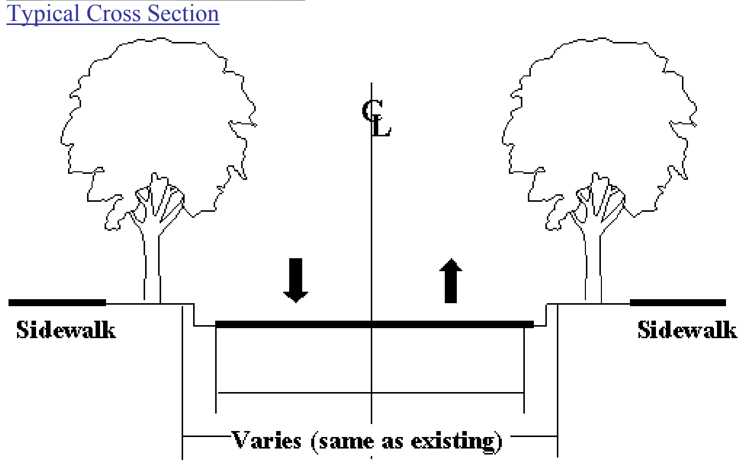
Four Lanes with a Landscaped Median

South Main Street from South Avenue (NC 98) to Holding Avenue

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	29 ft	50 ft	2	None	35 mph	Major	7,400	17,500
2025	29 ft	50 ft	2	None	35 mph	Local-Major	3,400	12,000

Looking South Toward Holding Avenue

Typical Cross Section



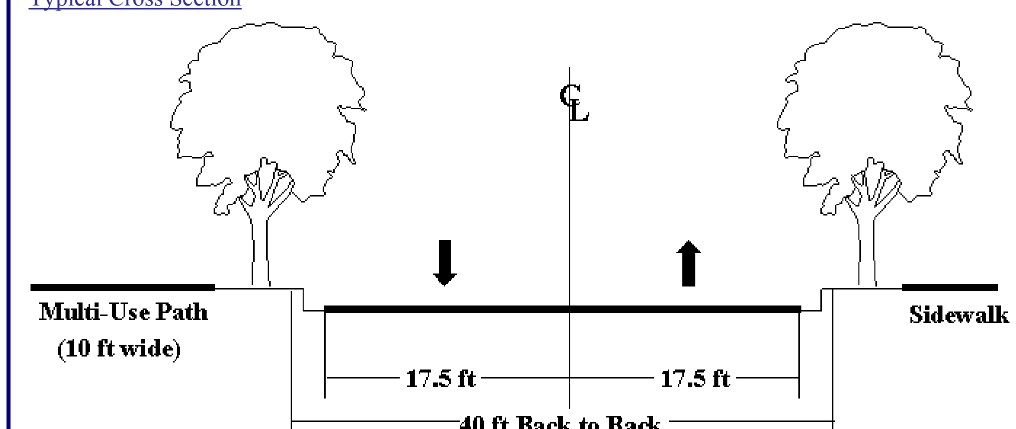
Two Lanes

South Main Street from Holding Avenue to the Planned NC 98 Bypass

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	40 ft	60 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Major	14,200	18,000
2025	40 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	15,000	18,000

Looking North Toward Holding Avenue

Typical Cross Section



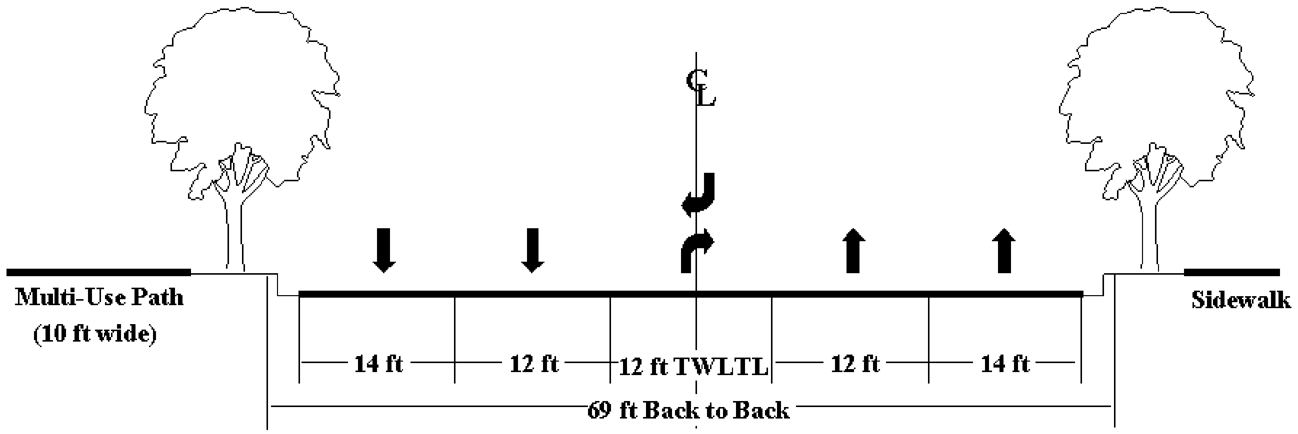
Two Lanes with Left-Turn Lanes

South Main Street from the Planned NC 98 Bypass to Capital Boulevard (US 1)

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	38 ft	60 ft	2	Two-way Left-turn Lane	45 mph	Major	12,000	18,000
2025	69 ft	100 ft	4	Two-way Left-turn Lane	45 mph	Secondary-Major	27,300	32,000

Between Forbes Road and Capital Boulevard (US 1)

Typical Cross Section



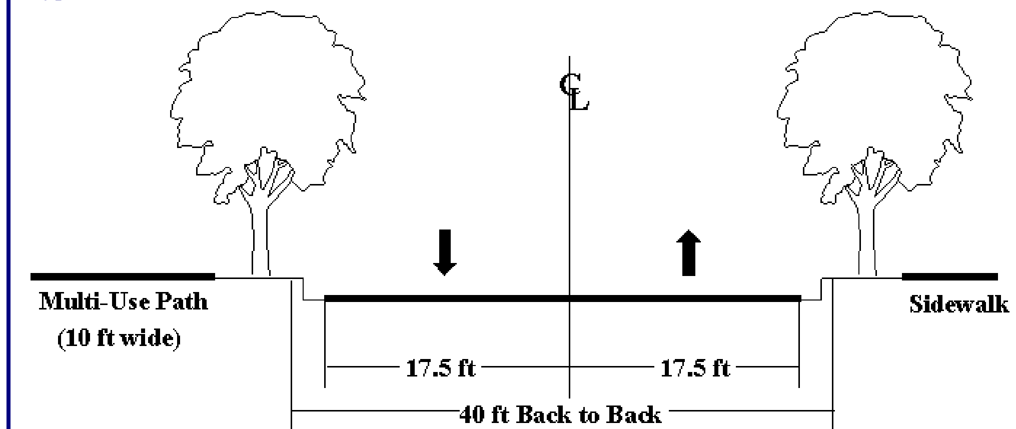
Five Lanes

Stadium Drive from Capital Boulevard (US 1) to Rock Springs Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	22 ft	60 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Major	6,100	18,000
2025	40 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Local-Major	1,600	18,000

Looking West Toward Capital Boulevard (US 1)

Typical Cross Section



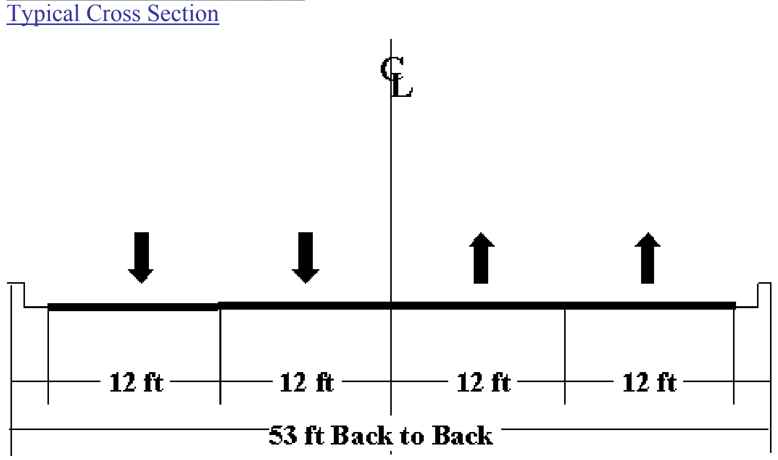
Two Lanes with Left-Turn Lanes

Stadium Drive from Rock Springs Road to Wingate Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	52 ft	70 ft	4	None	25 mph	Major	n/a	22,000
2025	53 ft	70 ft	4	None	35 mph	Local-Major	1,600	22,000

Looking West Toward Rock Springs Road

Typical Cross Section



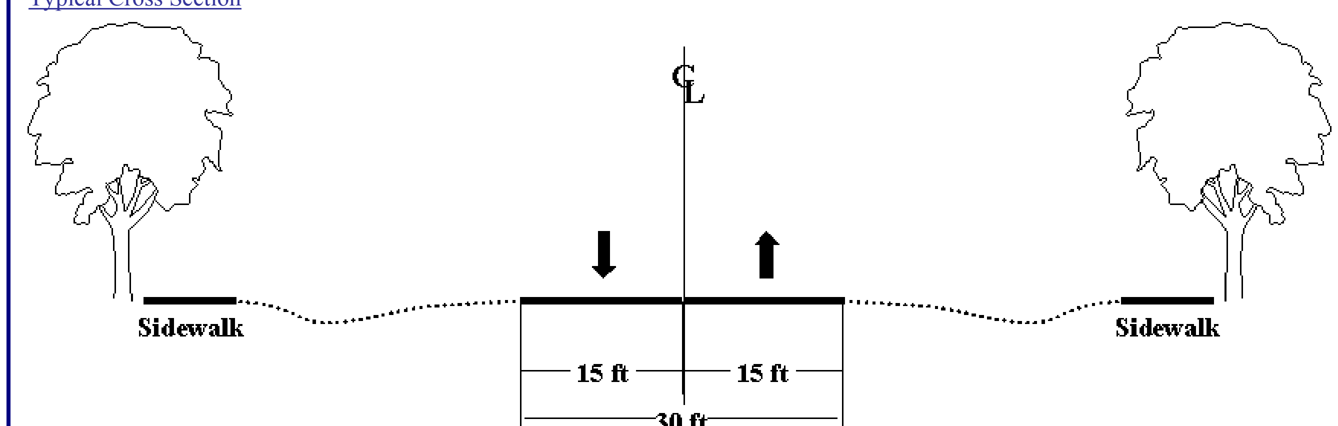
Four Lanes

Thompson Mill Road from Jenkins Road to Durham Road

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	60 ft	2	None	45 mph	n/a	n/a	12,000
2025	30 ft	70 ft	2	None	45 mph	Minor	11,400	12,000

Looking South Toward NC 98

Typical Cross Section

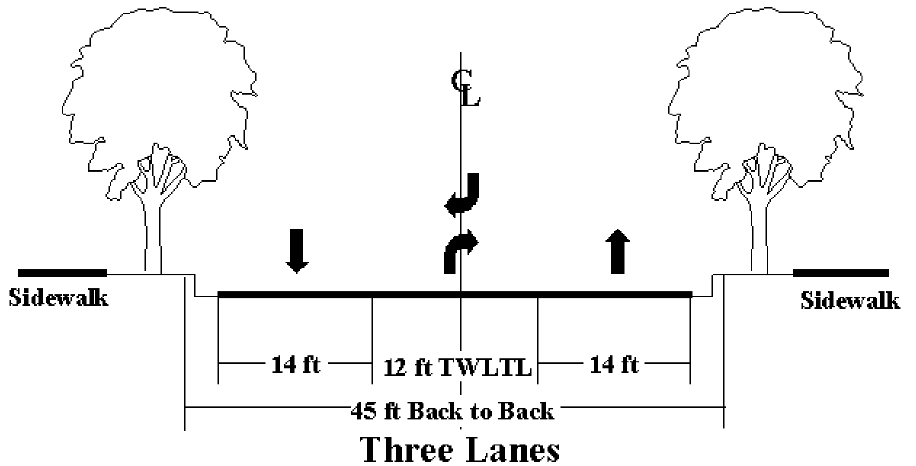


Two Lanes

Wake Union Church Road from Durham Road (NC 98) to Capital Boulevard (US 1)

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	60 ft	2	None	45 mph	n/a	n/a	12,000
2025	45 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Local-Major	2,500	18,000

Typical Cross Section

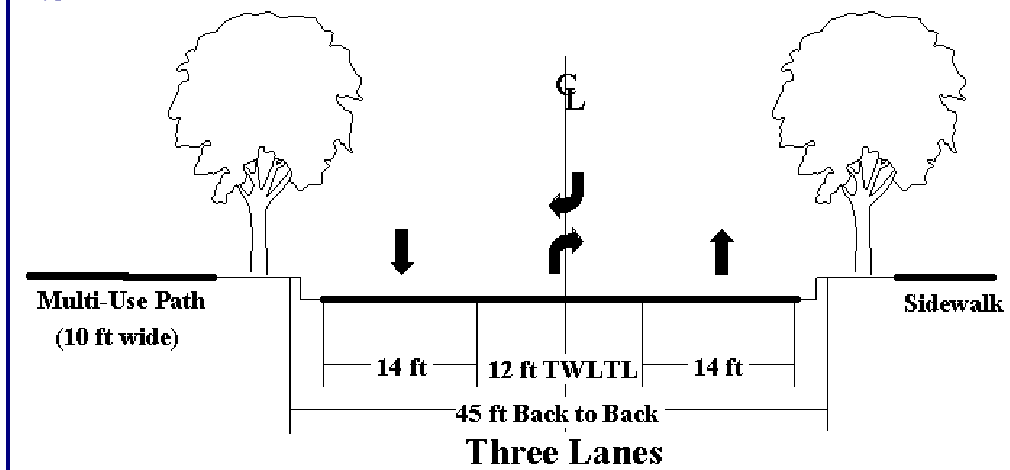


White Street from the Wake County Line to the Planned North Loop

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	60 ft	2	None	40 mph	Minor	5,400	12,000
2025	45 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Local-Major	5,400	18,000

Looking South Toward Juniper Avenue

Typical Cross Section

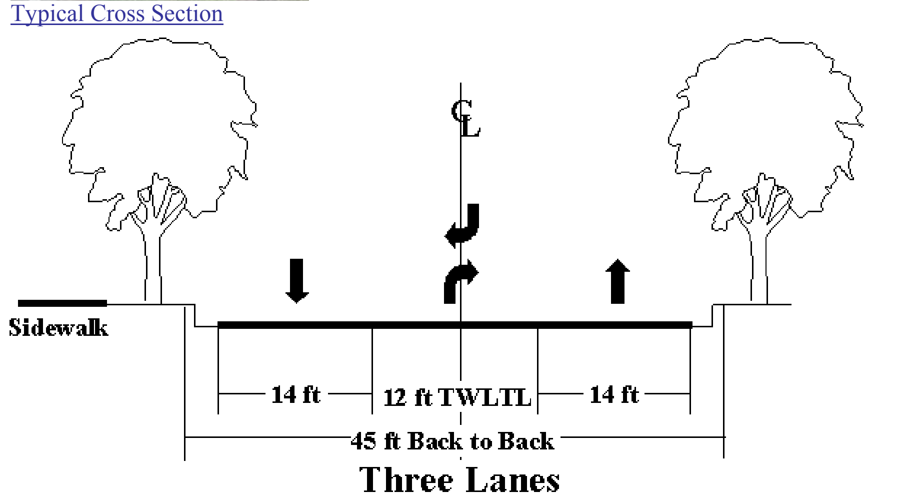


White Street from the Planned North Loop to Juniper Avenue

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	60 ft	2	None	40 mph	Minor	5,400	12,000
2025	45 ft	70 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Local-Major	5,400	18,000

Looking South Toward Juniper Avenue

Typical Cross Section

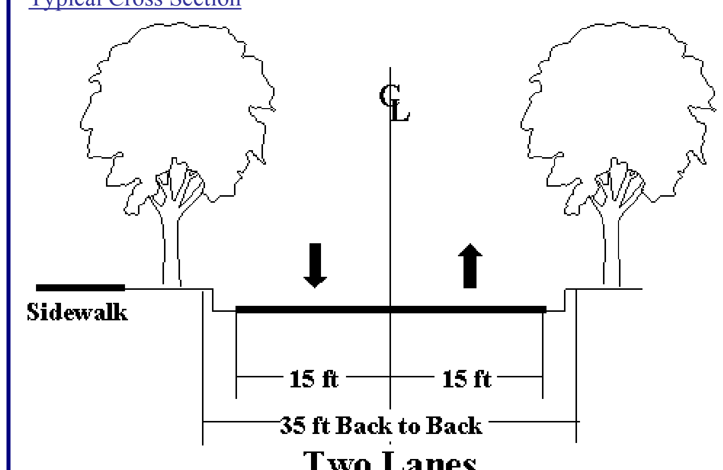


White Street from Juniper Avenue to Spring Street

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	45 ft	2	None	35 mph	Minor	n/a	12,000
2025	35 ft	60 ft	2	None	35 mph	Minor	2,500	12,000

Looking North Toward Juniper Avenue

Typical Cross Section

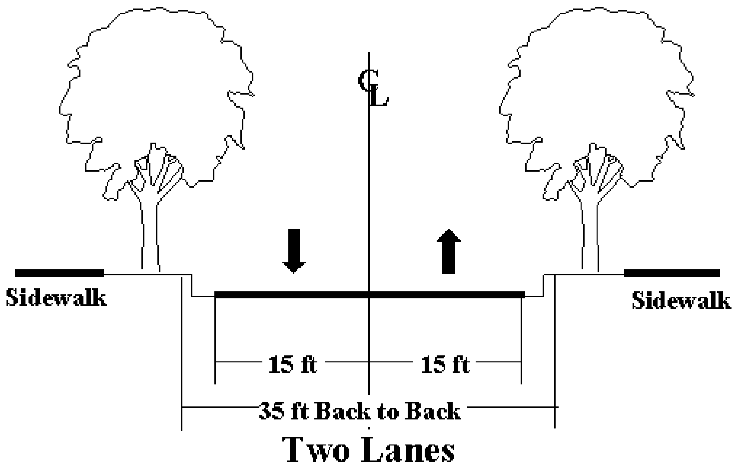


White Street from Spring Street to Roosevelt Avenue (NC 98)

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	35 ft	50 ft	2	Left-turn Lanes at Intersections and Driveways	35 mph	Minor	7,200	18,000
2025	35 ft	50 ft	2	None	25 mph	Minor	7,200	12,000

Looking South Toward Roosevelt Avenue (NC 98)

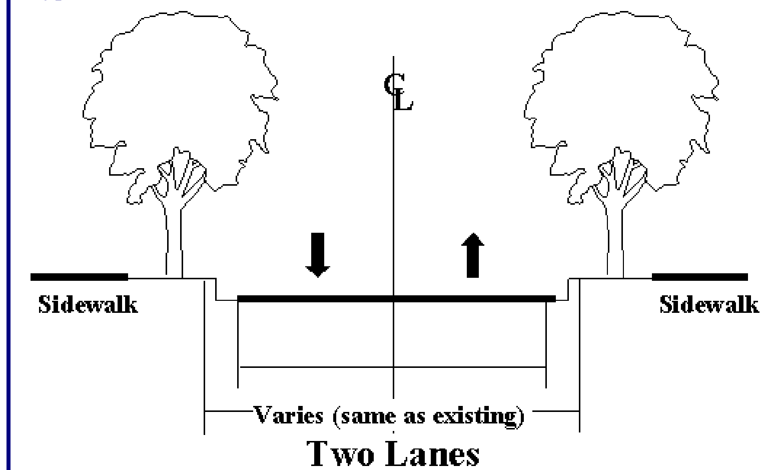
Typical Cross Section



White Street from Roosevelt Avenue (NC 98) to Elm Avenue

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	42 ft	50 ft	2	None	25 mph	Minor	n/a	17,500
2025	42 ft	50 ft	2	None	25 mph	Minor	2,500	12,000

Typical Cross Section

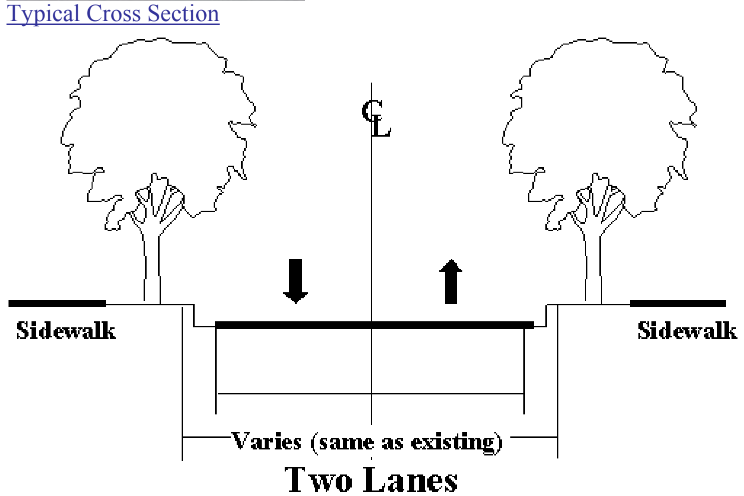


White Street from Elm Avenue to Holding Avenue

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	41 ft	60 ft	2	None	25 mph	Minor	n/a	17,500
2025	41 ft	60 ft	2	None	25 mph	Minor	2,500	12,000

Looking South Toward Holding Avenue

Typical Cross Section

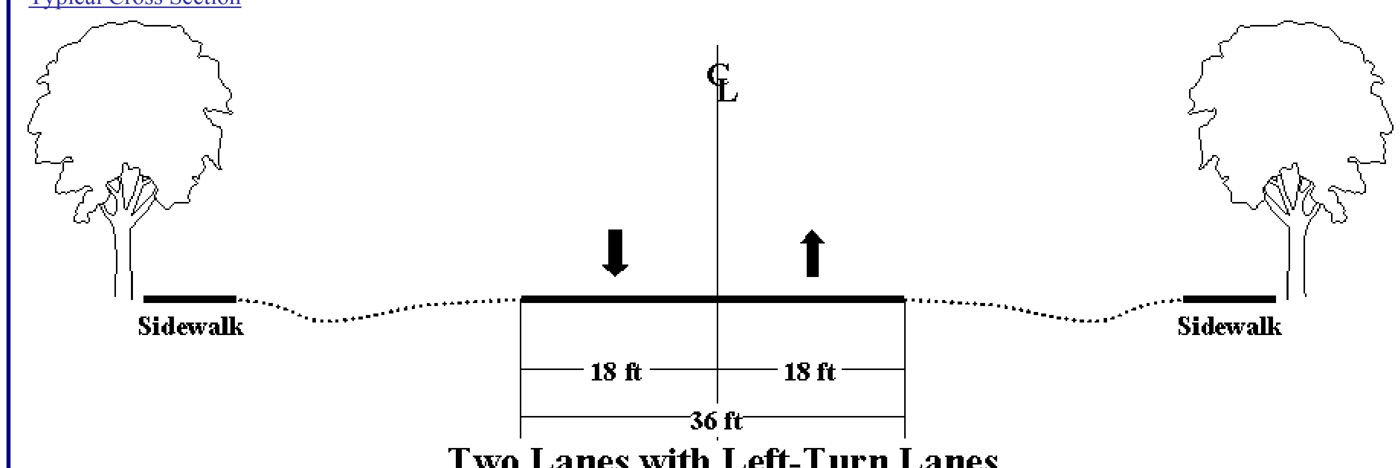


Zebulon Road (NC 96) from Oak Grove Church Road to Wait Avenue

Year	Roadway Width	Right-of-Way	Lanes	Median/LT Treatment	Speed Limit	Street Type	ADT	Capacity
2002	21 ft	100 ft	2	None	45 mph	Major	n/a	12,000
2025	36 ft	100 ft	2	Left-turn Lanes at Intersections and Driveways	45 mph	Primary-Major	2,000	18,000

Looking North Toward Oak Grove Church Road

Typical Cross Section



Appendix B—CAMPO Goals and Objectives

CAMPO Goals and Objectives (full excerpt from the CAMPO Transportation Plan)

INTRODUCTION

The Capital Area MPO set out in May of 1998 to determine its goals and objectives for [the] transportation plan. Citizen advisory committees (the "Intermodal Team"), public meetings, newsletters, surveys, and Internet contact were all used to determine these goals and objectives. On November 18, 1998, the Capital Area MPO Transportation Advisory Committee formally approved the following vision statement, goals, and objectives:

> *Our vision is* a multi-modal transportation network that is compatible with our growth, sensitive to the environment, improves quality of life and is accessible to all. The *Transportation Plan Update 2025* commits our region to transportation services and patterns of land use that contribute to a more attractive place where it is easier for people to pursue their daily activities.

GOAL ONE: DEVELOP A REGIONAL TRANSPORTATION NETWORK THAT IMPROVES QUALITY OF LIFE AND THE ENVIRONMENT.

Objective A: Encourage local and state governments to manage growth more proactively by linking land use patterns, plans and policies with transportation networks, plans and policies.

Explanation: *Our region's transportation facilities are not adequate for the ex isting and planned development patterns. Current growth management policies contribute to transportation problems. Local and state governments are reactive instead of proactive, and there is not enough emphasis on regional coordination between land use and transportation development. Land use policies and the resulting development patterns must better address transportation issues and implications.*

Objective B: Encourage equitable funding from Federal and state sources for a system that satisfies the region's transportation needs.

Explanation: *Due to the area's dramatic growth, there is a substantial need for transportation improvements, especially for highway construction. Primary funding sources for highway construction and improvements are the state and Federal gasoline taxes. A significant amount of the gasoline taxes that are collected here are not used to fund local projects. This objective expresses the desire to increase the proportion of state gasoline tax revenue that is used to fund projects in this MPO. There is also a desire to improve the state distribution formulae to insure that Federal highway funds are spent in areas of critical need.*

GOAL TWO: PROVIDE CONVENIENT, SAFE, RELIABLE AND AFFORDABLE TRANSPORTATION CHOICES, AND PROVIDE PUBLIC

EDUCATION ON THOSE CHOICES.

Objective A: Provide policies and infrastructure that make walking and bicycling more viable modes of transportation.

Explanation: *The local land use plans have not adequately integrated the walking and bicycling modes of transportation. The region needs to develop more facilities, policies and programs to make these modes of transportation more viable.*

Objective B: Promote the benefits of walking and bicycling as practical modes of transportation.

Explanation: *The region needs to begin new efforts to realize bicycling and walking as viable modes of transportation. Promoting the health, environmental and economic benefits of these modes of transportation would help the region realize those benefits.*

Objective C: Increase funding for alternative modes of transportation.

Explanation: *Funding for alternative transportation modes (including transit) is inadequate. Alternative transportation modes need more funding to give people a choice of transportation other than the single occupancy vehicle. Innovative ways of providing increased funds should be explored.*

Objective D: Promote land use policies that encourage transit alternatives in local and regional plans.

Explanation: *The local land use plans and policies and their implementation do not adequately accommodate transit-oriented development or other alternative transportation modes. Local and regional plans and policies should support transit alternatives.*

GOAL THREE: ENHANCE CONNECTIVITY BY DEVELOPING A MULTI-MODAL TRANSPORTATION NETWORK THAT PROMOTES ECONOMIC GROWTH THAT IS COMPATIBLE WITH THE ENVIRONMENT AND LAND USE PATTERNS.

Objective A: Improve mobility by planning facilities that enhance interconnectivity and accessibility.

Explanation: *There is a need to plan for and design interconnected facilities due to the region's growth. Facility planning for the region involves the need for interconnecting points to be accessible. These points should be linked to provide timely travel for all people in a seamless manner.*

Objective B: Improve the coordination of the metropolitan area governments, public and private transportation agencies, freight carriers and transportation users in order to plan for a seamless, interconnected transportation network.

Explanation: *There is a need to better coordinate the interconnectivity of the region. Transit needs to aid the roadway system in this region and there should be an effort to seamlessly coordinate the different companies that serve the Triangle. Because there will be transit route redirection due to the rail/transit relationship in the future, some degree of coordinated planning needs to occur. The key element to this issue is regional coordination for people and goods movement. A major reformation of the transit systems in the Triangle should be reviewed. All parties, including the public, should work to achieve a seamless connection between the systems.*

Objective C: Develop a better process for identifying, evaluating and prioritizing transportation projects.

Explanation: *The process for locating and prioritizing transportation improvements is not always successful. It does not adequately address public input, is not equitable and is not always technically defensible. The process for selecting projects to be funded needs to be reviewed and overhauled. The objective is to ensure that appropriate ways of measuring the need for each project are used. It was felt that public input was only received when the project had been under study for some time. It would be better to receive public input from the beginning of the project's conception. The inability to schedule projects equally across the metropolitan area was also recognized as a shortcoming to project selection. The location of these projects needs to be communicated to the public with a more up front approach.*

GOAL FOUR: DEVELOP AN EFFICIENT TRANSPORTATION NETWORK THAT IS BOTH AFFORDABLE AND RELIABLE FOR THE MOVEMENT OF PEOPLE AND GOODS.

Objective A: Identify new and alternative funding sources for constructing and maintaining transportation infrastructure.

Explanation: *Funding sources are inadequate and are not effectively or efficiently meeting the needs for transportation improvements and maintenance. There is too much reliance on state and Federal funds. There is too little promotion of innovative funding sources. There is a need for additional funding sources to handle the tremendous amount of traffic that is increasing in our metropolitan area. These new funding sources can come from locally added revenues, statewide efforts, regional efforts and private initiatives. It may be possible for the users of a facility to consider paying fees for specific improvements. There is a need to research the various methods used to fund new facilities, programs and transportation system management tools.*

Objective B: Maximize the highway system efficiency using means other than adding general-purpose traffic lanes.

Explanation: *When evaluating major expansion of the transportation systems, other methods of improving system efficiency should be addressed. New technologies should be tested in our transportation system. Improvements to transit services and education to the public should work toward common goals to improve transportation efficiency. The metropolitan area needs improvements to provide better access to transportation facilities and programs. There is a need for improved access to facilities that have been constructed. New intelligent transportation technologies should help with allowing balanced access and mobility.*

Appendix C—Supplemental Information

ACCESS MANAGEMENT
INTERCONNECTED STREET SYSTEMS
DEFINITIONS
THOROUGHFARE PAVING POLICY
TRAFFIC IMPACT ANALYSIS (TIA) GUIDELINES

Supplemental Information

ACCESS MANAGEMENT

Access management includes the implementation of policies and roadway features to manage the movement of vehicles along a street. Policies and design solutions are varied and can be adapted to fit different situations. Several published documents can help with the selection of appropriate measures as access management policies are established and specific measures designed and constructed. The National Cooperative Highway Research Program (NCHRP) has published *Report 420, Impact of Access Management Techniques,* which provides an assessment of access management techniques. Another good resource for policies and design solutions is the North Carolina Department of Transportation's access management policy document, currently undergoing revision. This document also provides policies, strategies, and potential solutions for access management.

Common examples of access management measures described in the aforementioned documents include:

- Establishing adequate signal spacing
- Establishing adequate unsignalized access spacing
- Constructing median treatments
- Providing appropriate median openings
- Providing left-turn lanes
- Providing alternatives to left-turns

A summary of selected measures is described in the following.

Signal Spacing—Appropriate signal spacing is critical in being able provide good two-way vehicle progression along a corridor. To facilitate good signal coordination, traffic signal spacing at multiples of ¼ mile is recommended for roadways with a 45 mph speed limit, although this does not mean that a signal is warranted at every ¼ mile interval. Depending on desired speeds on a roadway, signal spacing should be adjusted accordingly.

Unsignalized Access Spacing—As unsignalized driveways and intersections are planned and constructed, they should be spaced such that those that are likely to be converted into signalized intersections are spaced similar to existing intersections with signals.

Median Treatments—Two types of medians are typically constructed on roadways:

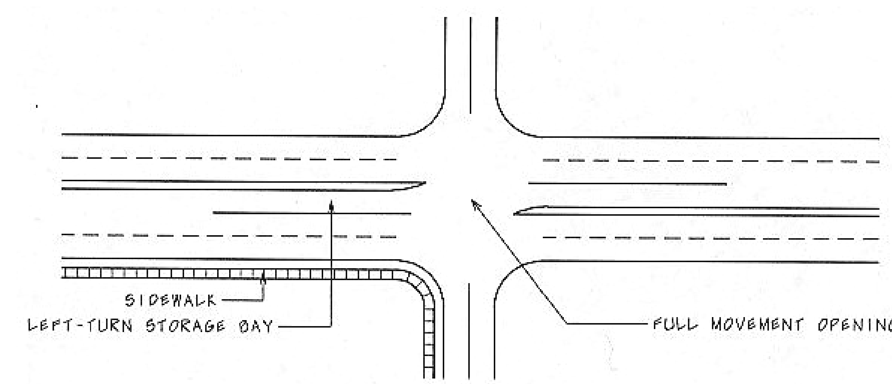
- Continuous—Two-way left-turn lanes (TWLTL)
- Raised medians

TWLTLs and medians improve traffic operations and safety by removing left-turning vehicles from through travel lanes. TWLTLs provide greater access, greater operational flexibility, and require five to ten feet less right-of-way. Raised medians provide greater access control, less risk of vehicular crashes, and better pedestrian refuge. Median design requires careful consideration for left turns and U-turns to avoid issues associated with concentrating these movements at signalized intersections.

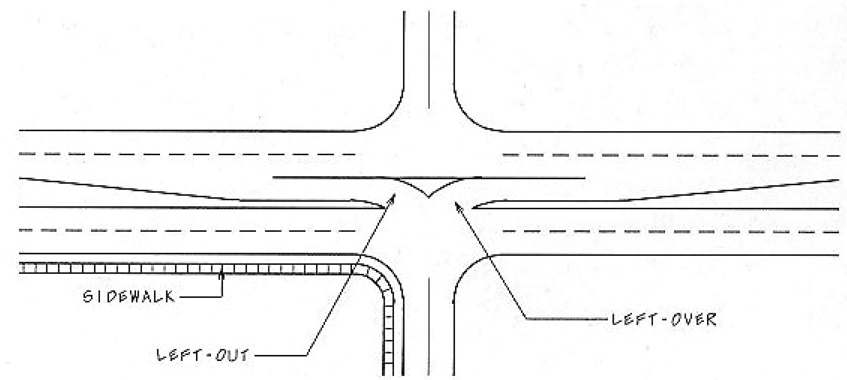
Median Openings—Median openings are identified in one of two categories—full or directional. A full median opening accommodates all turning movements whereas a directional opening accommodates only specific movements through channelization. Examples of different types of median openings include:

- Full movement
- Left-over, left-out
- Left-over
- Left-out
- Right-in right-out

The North Carolina Department of Transportation's access management policy requires that full median openings are spaced a minimum of 1,500 feet apart when the posted speed is 45 mph.

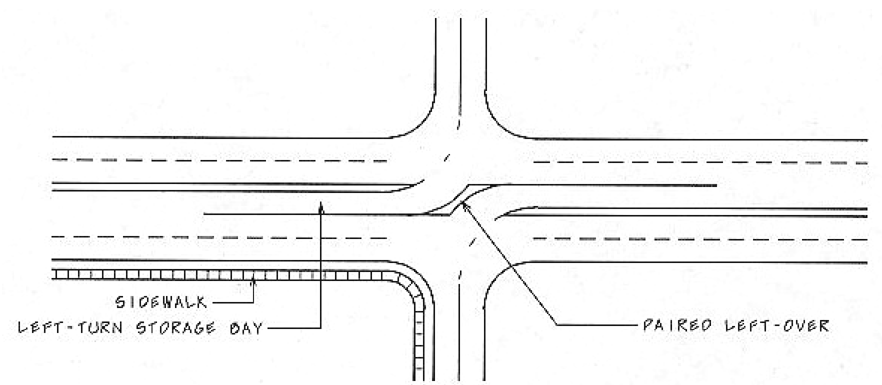


Full Movement Intersection



Left-Over, Left-Out

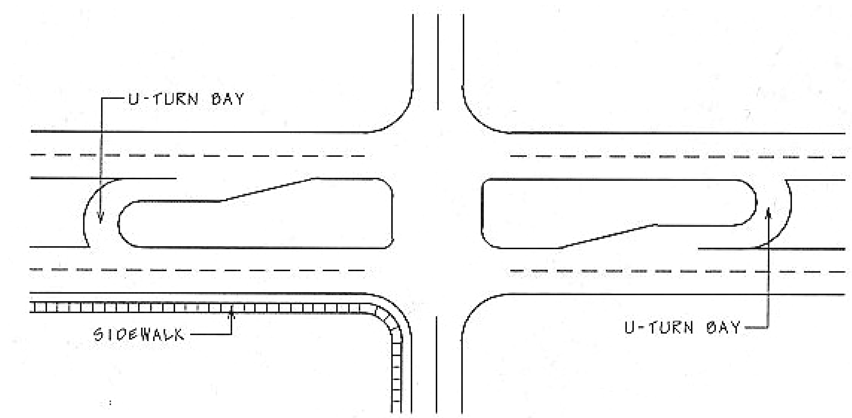
Left-turn Lanes—Providing adequate left-turn lanes and appropriate storage bay length is important for roadway capacity and safety. Left-turn lanes remove through vehicles from turning traffic, improve the visibility of oncoming traffic to left-turning vehicles, and reduce rear-end collisions.



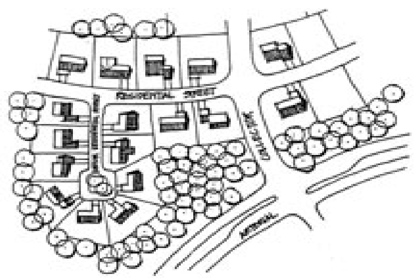
Paired Left-Over

Alternatives to Left-turns—In some cases it is necessary to control where left turns can be made in a corridor. In other cases left-turns must be restricted altogether. In these cases, the left-turn movement can be displaced to a more suitable location with a lesser impact. There are numerous alternatives that can be applied in these situations. Examples include:

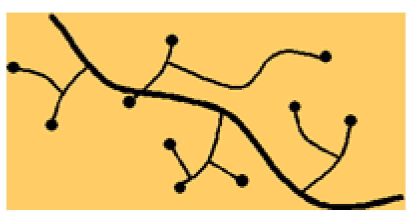
- Median U-turn
- Jug Handle
- Automated gate controlled left-turn access



Median U-Turn



Typical Suburban Street Hierarchy



The "Dead Worm"

The Grid Taken to Extremes—the Plan for Savannah, Georgia

INTERCONNECTED STREET SYSTEMS

Report by Dan Howe, AICP and Ed Johnson, P.E., City of Raleigh

Is this a legitimate public policy issue? It seems logical that a grid street pattern should be able to allow efficient municipal services and other governmental and quasi-governmental functions such as school transportation, mail and package delivery, but does it really make a difference? Evidence shows that if a reasonable grid of streets is maintained, the vehicle trips on all residential streets can be held down to a modest, safe traffic load, made up almost entirely of local trips (not "cut-through" trips") and that this can be done at a level which is no more costly to the developer than the more common collector-and-cul-de-sac pattern. Many argue that connected streets mean more interaction between neighbors, create a design framework that fosters quality urban architecture and spaces, and can reduce response time for emergency service providers. It seems to make sense that the public encourage streets to connect in a relatively dense grid pattern, no? For some...that's the answer: No. Not my street, Buster...

This issue is a classic planning decision-making conundrum. A lot of evidence can be brought to bear that long-term costs of providing municipal services such as fire protection, refuse collection, thoroughfare widenings and EMS services are affected by residential street patterns and that some level of interconnectivity needs to be maintained. At the same time, the prospect of implementing a connection to an existing residential neighborhood is invariably met with staunch opposition by those already living there, who are concerned about the safety and livability of their immediate environment.

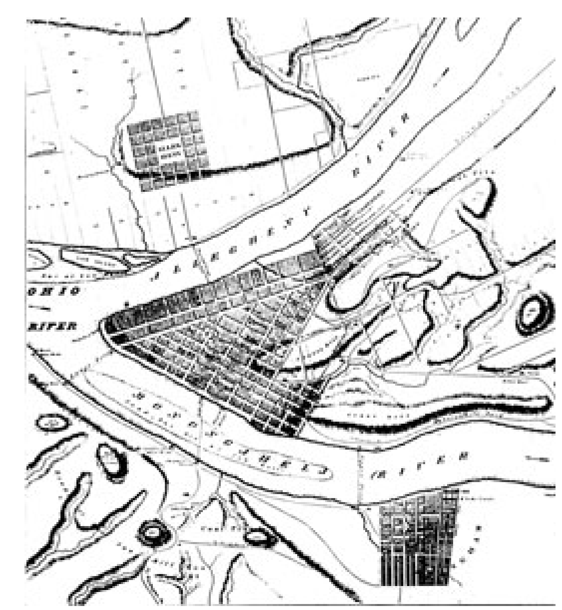
How much interconnectivity is too much? Is there such a thing? New Urbanists are major supporters of more interconnected street systems on a very tight grid akin to that established in the early 20th-century neighborhoods of the US. This model for new developments is becoming popular, and is certainly driving debate about city design. Environmentalists, on the other hand, may find fewer streets in general to be better. Classic collector-and-cul-de-sac systems (termed by New Urbanist guru Andres Duany as "the dead worm") require less street and follow the contours of the land more closely, requiring less land disturbance to construct. It can be shown that dead-end systems can be efficient from a development point of view, serving more units with less linear footage of pavement.

It all comes down to what sort of city we want to create. If folks don't mind paying higher taxes for refuse collection, and don't mind sitting in traffic at collector street intersections, should they not be able to live at the end of the cul-de-sac? Maybe so. Should the citizen dwelling in an interconnected neighborhood which is efficient, pleasant and safe have to pay extra taxes and suffer suburban traffic gridlock in order for others to live at the end of the cul-de-sac? Maybe not. Like most democratic solutions, the right answer is probably somewhere in the middle. Whatever the ultimate level of interconnectivity in a local street pattern, we argue that the maintenance of a generalized grid of residential streets is a legitimate public policy issue that local government should establish a set of standards for. We also argue that there are a variety of solutions that establish a reasonable grid of residential streets, continue to allow for some dead-end streets, protect the environment and still allow the fire truck to get to the fire.

HISTORICAL TRENDS IN STREET SYSTEM DESIGN

A Short History of the Grid

The grid made sense to the early town-builders in this country, primarily because it was a paradigm for convenient and efficient land sales. Simple, easy to measure, easy to know where your Monticello ended and the next man's began, the grid layout of lots divided by streets was the design of choice whether on the flat plains of Kansas or the tortured geology of riverine western Pennsylvania. Streets, in the days where the grid marched unchallenged across the landscape of town planning, were mostly the spaces between saleable lots. Unimproved for the most part and subject to utilization primarily by horse hooves and wagon wheels, streets which would become the skeleton of modern city form were laid out strictly for utilitarian access to property. With a few exceptions, very little thought was given to how this particular form would affect privacy, "traffic" (not really on the radar screen in the 19th century), interaction between and among communities, or even the efficient provision of services. It was a real estate tool first and foremost.



Plan for Pittsburg. The Rectilinear Grid Assaults a Topographically Challenged Site

The Grid Bends...Boylan Heights, an Early 20th Century Raleigh Neighborhood

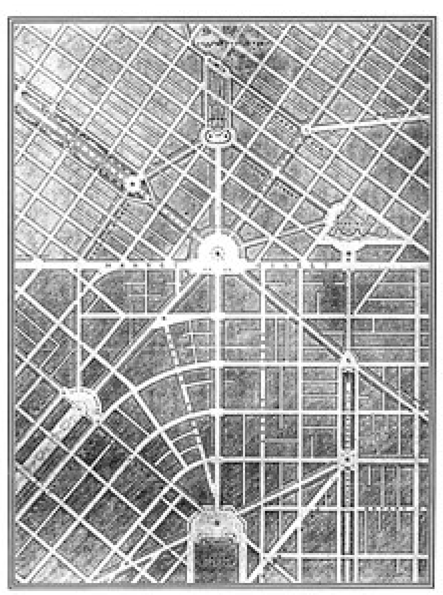


Figure 309. Burnham's Plan for the San Francisco, California Civic Center: 1905

San Francisco Civic Center Plan

Around the turn of the 20th century town planners began to nudge the grid, bend it and slice it apart diagonally. Pierre L'Enfant and Daniel Burnham loved the urban design potential of the grid, particularly when it was enhanced with broad diagonal boulevards that provided views and a hierarchy of importance to streets that was less apparent in the layout of the traditional grid. Spice that liberally with voids... plazas and squares, and the City Beautiful designs of Chicago and Washington DC are the result. Much of this conscious urbanism that has now spawned the nostalgic return to these concepts in the guise of the "new" urbanism reflect Burnham's, L'Enfant's and Raymond Unwin's attraction to this "enhanced" grid of streets. Topography, natural features, hydrology played little role in shaping this emerging urbanism. The form itself was primary. In fact, the conflict between the grid and natural topography actually enhanced the rectilinear grid by adding a third dimension and a creative foil to the monotony of evenly-spaced blocks marching across the landscape.

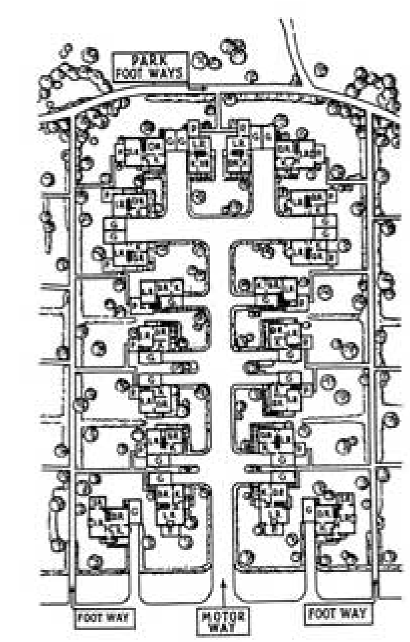
All this began to change in the first couple of decades of this century, when designers of streetcar suburbs began to find it cheaper and easier to build with the land rather than against it. More importantly, buyers of suburban homes seemed to actually enjoy the closer connection to the topographic underlayment of their communities, its contrast to the stiff urbanity of downtown's grid. The grid began to bend around the contours of the hills it was laid upon. The "curvilinear" streets were aesthetically satisfying in their own right, still afforded a generally efficient means of selling residential property, and reduced the cost of development by reducing earthwork in general. But it was still a grid. There were few or no dead-end streets even in these curvilinear designs. The design of Radburn NJ is generally credited as the progenitor of the "cluster" subdivision, with discrete clusters of dead-end "streets" (both vehicular and pedestrian) that existed within a more traditional grid. It didn't turn a lot of heads at the time, but its grandchildren are all around us today. Its real value wasn't made apparent until later in the century. As with all else urban in this country, as automobiles began filling up garages across the land, everything changed. It's not that the grid went away. It just got bigger. And the spaces between began to be filled up by newer, more efficient and more environmentally sensitive patterns of access to residential properties.

The automobile made possible the development of tract housing in the 50's and 60's. Large areas of land on the far fringes of the existing city could be planned and developed at one time as discrete communities, not simply extensions of the existing urbanism. They were connected to the grid, but not of it. In fact, it made sense to distinguish one's development from the rest of the community to be able to market it as a new, better kind of place to live. Even these pioneering developments continued to use the curvilinear grid as the basic building-block, even though the edges of the development were effectively sealed, but for a few carefully planned connections to the wider grid of major streets. As cities grew rapidly further and further from the old densely-gridded centers, the only remnant of the grid became a large network of old cow-path traditional rural highways, gentrified into suburban thoroughfares. These became the "superblock" suburban grid. Beginning in the 1970's we began to fill it in with what we learned from Ian McHarg.

McHarg's seminal 1972 work, Design with Nature, showed compellingly how the natural form and systems of the landscape are not impediments to be overcome and engineered into obscurity in our communities. Nature is the basic building block of city form, and when analyzed carefully for a variety of clues to where urbanism and natural form can co-exist, it will tell us what form our community is to take. Instead of engineering complex structures to allow us to overcome natural systems and impose our rectilinear grid upon it, McHarg taught us to design around sensitive natural areas, respecting what they tell us about where streets and buildings should go. Landscape architects and planners across the country embraced the elegant logic of this theory, and began designing urban areas that fit the land, aided ably by development advocacy organizations who began to publish how-to manuals extolling common open space, clustering of housing on smaller lots, and the use of dead-end streets. Designers began to realize that "cul-de-sacs" made possible an overall reduction in the amount of street infrastructure necessary to serve a fixed number of units and eliminated the need for most expensive stream crossings. On top of all this cost reduction, the marketing people realized that this pattern had revenue benefits as well to the developer.

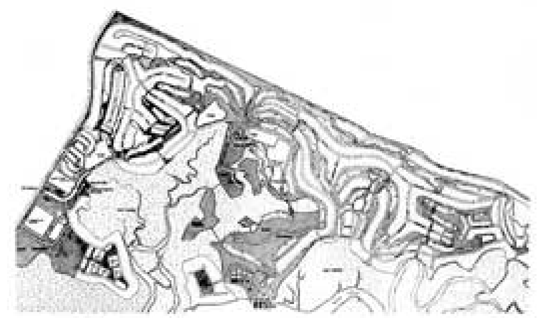
They could, and still do, demand a premium for residential lots that front on dead-end streets.

Wow, this all seemed like a win-win arrangement for quite a while. Not only were we being environmentally aware, but we were generating urban forms that were unique...we were making our own statement in the latter half of the 20th century. This was a new thing...almost a rejection of the City Beautiful insistence on geometry as the determining form of a city. We were designing "new towns" around these principles in Reston, VA and Columbia, MD. We were giving people privacy and a connection to the land within commuting distance from their source of work and



The first cul-de-sac? Radburn, NJ

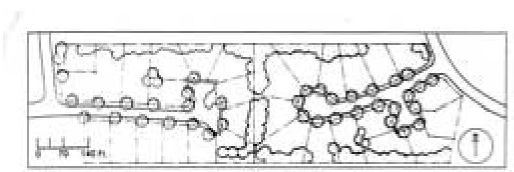
wealth. We were doing it all in a context that was in the developers interest, and the whole program seemed so much more sophisticated than the Levittowns of the 50's and 60's.



The "Design with Nature" movement encouraged clustering and curvilinear streets that followed contours and avoided sensitive natural areas.

So Why Go to Grid?

Does it make sense today? Streets in this country in urban areas are now paved (for the most part), carry automobiles at sometimes breakneck speed, are generally wider, more dangerous, and used by far more entities from utility companies to kids on skateboards than their 18th and 19th century ancestors. 19th century streets were the negative spaces between valuable land. 20th century streets are the creators of land value. They are expensive to build and maintain but carry all the nectar of land value to the target...water, often sewer, electricity, buyers. Without these things land at the fringe of urban areas is just land. With it, the land becomes wealth. But why a grid? Convenient in a time of limitless cheap land, the grid has become somewhat inefficient from the point of view of land development now. Land sells by the square foot.



This excerpt from an Urban Land Institute publication from the 1970's encourages the use of dead-end streets and clustering.

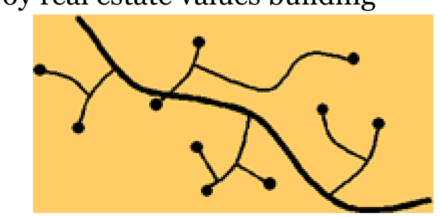
Streets don't sell for anything. They just make possible sales on adjacent property. Why run streets north and south if you can provide access to your property by the east or west only? Why make streets continue through the entire development if they need only go part way through to provide access to all the property? Why not maximize the square footage of marketable land by providing the absolute minimum in access to residential property in particular?

Proponents of New Urbanism counter that, even if you discount all the obvious efficiency advantages of providing municipal services on a grid system of streets, the grid is still better as a framework for successful urbanism. The New Urbanism is gaining in popularity because it speaks to a living style that otherwise seems unreachable in our typical suburbs. Oft dismissed as an architectural solution to a planning problem, it is, like City Beautiful, like Frank Lloyd Wright's Broadacre City, like Levittown, a paradigm of planning meant to alter the social character of community.

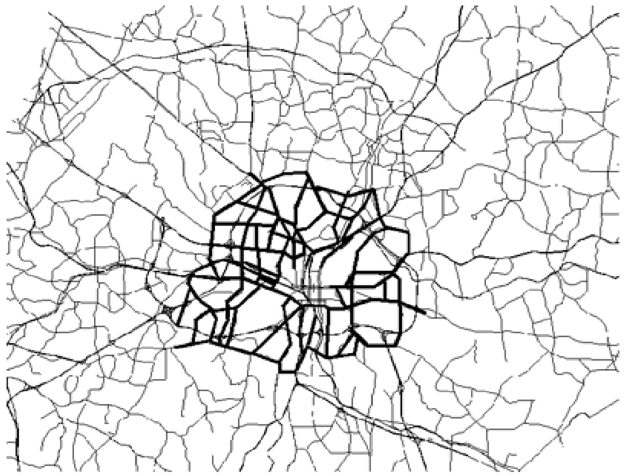
"New Urbanism" project from Memphis harkens back to San Francisco and Pittsburgh grid plans.

Essential to true New Urbanism is a mixture of uses, a mixture of housing types and sizes and above all, connectivity not separation. The grid unites where the cul-de-sac divides. The New Urban city is a community. The suburbs are enclaves. This separation is reinforced by the street pattern New Urban guru Andres Duany calls the "dead worm".

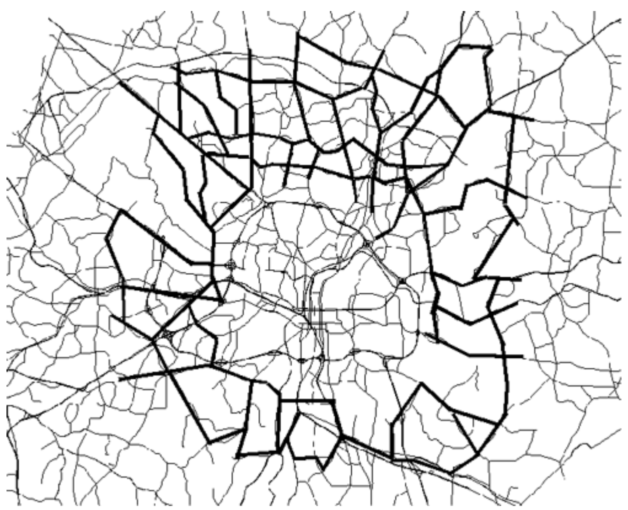
New Urbanists champion the classic rectilinear grid for the center of a community, and allow it to evolve into a more curvilinear grid with distance from a center. The grid is dense. The narrowest street, they argue, consistently has the highest land value. Traffic, when distributed through many, smaller, interconnected streets, is naturally calmed but still flows. Why destroy real estate values building wide, high-speed roads when you can build a network of boulevards and residential blocks? Designers working with this theory often use diagonal streets like L'Enfant and Burnham. In the model the street is a positive space, a contributor to the connections between people, not just a conduit for water, trash collection and vehicles.



The street pattern called the "dead worm" by Andres Duany.



Major street grid in the 60's and early 70's



Ever-expanding grid of major streets in the 80's and 90's.

The ever-expanding web of major streets is going to be the model for transportation systems in the future. Because jobs are spread much more widely, the old radial forms (spokes of a wheel) for thoroughfares and transit corridors do not make sense. Whether we choose to infill this grid of major streets with a denser grid of residential streets, or with the "dead worm", is in great measure determined by what sort of a city we wish to build, how connected we wish to make our neighborhoods both functionally and socially, and how much future taxpayers may be willing to pay in additional costs for urban service for the luxury of privacy and exclusivity.

Neighborhood Protection

It may make perfect sense to planners to work toward connecting up the residential street network in their communities, but it doesn't to everybody, and sometimes when the dots get connected the political atmosphere gets charged. Tripp Johnson is one of the folks in the middle of this combustion chamber, and his point of view is unequivocal. "The biggest thing about this is it doesn't serve any purpose," Johnson says. "There are probably 35 kids on this section of street. We can get around out to the thoroughfares now. It's a natural cut-through. It just doesn't make any sense." Johnson and his neighbors have petitioned the City Council to reconsider a request by the adjacent neighborhood to pave their existing unpaved streets. In the process, a stub street from Johnson's early-90's-era subdivision will connect with Hinton Street, a gravel road in an old neighborhood of small houses that far pre-dates Johnson's. This older, predominantly African-American neighborhood is a classic "donut-hole", a forgotten oasis of rural living which has been surrounded by suburban development in northwest Raleigh. The development of a soccer field on a vacant tract spurred the Council to consider a petition project to improve all the streets in the neighborhood to City standards. One part of this paving project would connect them, as long planned, to the Hinton Street stub.

Issues like this one create a considerable conundrum for elected officials. For years Raleigh's policy has been to connect street systems wherever possible. A relatively conservative City Council passed regulations requiring stub-outs in new subdivisions to create blocks of approximately 1500 feet on a side. The text change was not controversial. But when the issue strikes home, the tone of the discussion changes. Visions of small children squashed on the pavement and NASCAR traffic speeds on residential streets spur neighbors to print flyers and buttons and show up in the Council chambers in numbers. If considered on a strictly political basis, there is no question about the result. Why anger so many over so little? Why not let them control their own neighborhoods access? The more you know, the more difficult this is. Political salve in this case, and the next, and the next may eventually end up in a tax increase to support the inefficiencies created for municipal service delivery. Elected officials must worry about response time for emergency service providers. They also realize that from a traffic standpoint this is a zero-sum game. Traffic that cannot use this particular stub will use another street to get to the same place, perhaps unnecessarily going through one or two major thoroughfare intersections to get there.

The more streets that are cut off, the more residential traffic internal to a major block must be diverted to "collectors", which in many communities become de facto thoroughfares themselves. This makes life miserable for the folks who reside directly on these through streets. Educated Councils understand that appeasing an angry crowd now may simply result in a larger, angrier crowd of collector street residents later, calling for traffic calming and more interconnectivity, after the traffic on their streets reaches beyond the limit of tolerance.

The Neuse River...Raleigh's primary water source.

Public Policy Trade-offs

Public Services

Water—Though water flows from a dendritic drainage system (little creeks flow into bigger ones which flow into rivers, etc.) into our municipal water systems, it does not work to distribute it back out that way after treatment. Dead-end (dendritic) water systems suffer from chronic lack of water pressure. Water is continually drawn off along the pipes until by the end, just like the Colorado River as it slowly trickles across the desert in Mexico trying desperately to get to the sea, there is very little left at the end of the pipe. Water systems work far more effectively when the pipes can be looped and interconnected, allowing even pressure to be distributed throughout the network. Because municipal water pipes are typically built within streets, Cary, North Carolina, a fast-growing and affluent neighbor of Raleigh's, enacted street interconnectivity standards in 1999 based in great measure on the need to interconnect the water system (which is typically built in public street rights-of-way). That was enough for the Town Council to buy the whole idea, but it is not the only service provision issue.

Garbage Truck

Garbage—One of the basic services provided by municipalities is trash collection. No one has yet figured out a better way of serving single-family residences than driving a large truck around town to every single home, picking up the refuse either by hand or mechanically, going on to the next house and eventually to the landfill to dump it. Like many municipal refuse collection systems, Raleigh workers have a set route. If they go fast they get done early and can cut their day short. The wise ones vie for routes in the older parts of town where the city is organized in a grid or curvilinear grid. One reason for this is to avoid dead-heading. On a dead-end street the truck works its way down to the end, picking up trash at each residence. Once at the turnaround, everybody hops on the truck and drives back down the street, "dead-heading", until the crew gets to the next street. While they are riding they are burning gas, time and vehicle wear-and-tear and are picking up nobody's refuse. This costs money. Interconnected residential street networks mean you never back up. If the grid is a dense one with houses close to the street, even expensive back-yard pickup can be reasonably efficient. In the cul-de-sac friendly suburbs, workers have to use a lot of fuel and shoe leather to serve the same number of homes.

Environmental Issues

Some of the most powerful barriers to a regularly-connected grid of streets are erected by planners...environmental planners, and their issues are no less valid than those of street interconnectivity proponents. John Dorney is one of them. Dorney is head of the wetlands division in the Division of Water Quality (DWQ), a powerful subsection of the NC Department of Environment and Natural Resources, whose daunting task is to address the severe water quality issues the state has experienced in recent years. Fish kills and pfisteria scares in the Neuse River have resulted in a basin-wide management plan that enforces vegetated riparian buffers 50' in width from the stream banks of every blue-line stream that shows up on the USGS quad maps in the Neuse River Basin. This area covers the entire City of Raleigh, large parts of Durham, Smithfield, Kinston, New Bern and thousands of acres of rural and farmland from the Piedmont to the coast.

Appendix B16 Caption:

- Riparian Buffers have been shown to remove 70-80% of the sediment, 50% of the phosphorus, 75% of the nitrogen in urban stormwater runoff.
- Culverts are biologically dead underneath.
- Bridges still cost roughly 3 times what a culvert costs to construct.
- Every time a stream is crossed with a road, wildlife migration patterns and biological filtering systems are disrupted.

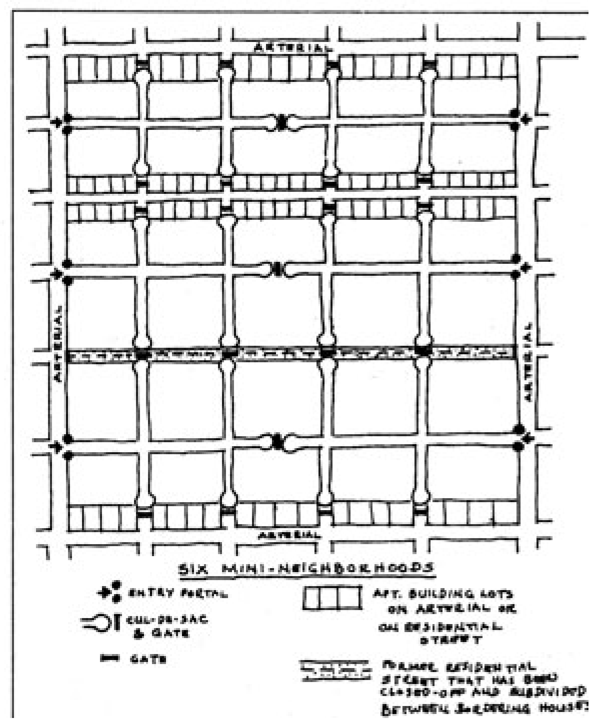
This map shows riparian buffers in a developing area of Raleigh. These corridors are regulated by the NC Division of Quality, which can deny a permit for road crossings of these riparian areas, no matter what Raleigh's development regulations require.

"We understand that there are good planning reasons to connect these streets." Says Dorney. "For a lot of developers access is important. These rules give us the power to deny a permit to fill in the buffer zones to cross a stream, thus limiting access. We know that, but I tell you...we don't really care. Our job is to fix the water quality issue, and there is a lot of evidence in the literature that buffers work." Dorney is not being arrogant about this. He's a scientist. This is an issue of substantial concern in North Carolina, with rural farming interests blaming urban regions and vice versa for the Neuse River water quality problems. And buffers work.

The 50' buffer imposed by the State of NC (30' of which is undisturbed) removes 70-80% of the sediment in stormwater runoff, 50% of the phosphorus and 75% of the nitrogen. More stream crossings mean more impervious surface draining directly into the streams and less buffer area. But the real reason stream crossings are bad from an environmental standpoint is biological, not chemical. Under a typical road culvert the stream is dead. There is no light and no natural stream bed. The fill necessary for the road and culvert creates a barrier to the migration of animals along the stream corridor. These corridors are essential for wildlife to find new food sources and mates in a protected environment. Bridges are far better from a biological standpoint, but right now they cost about 3 times the cost of a standard culvert. Even if a clever engineer figures out how to reduce the cost by half, a bridge will still be more costly than a culvert.

Public Safety

How do interconnected street systems affect public safety? Well, if response time is the major concern, the Fire Response Research Project noted on this site makes a strong case for interconnectivity. Overall acreage covered from a single point is roughly double in interconnected street networks when compared to a collector and cul-de-sac system. For emergency services like fire protection and EMS service, the value of an interconnected street network in getting the provider to the emergency appears to have validity. But that is not the only criteria for public safety when it comes to community policing.



This sketch, from "Creating Defensible Space" by Oscar Newman, shows how to retrofit an existing grid to establish "mini-neighborhoods" where access is limited to a single point, and through connections between neighborhoods are controlled by locked gates (below).

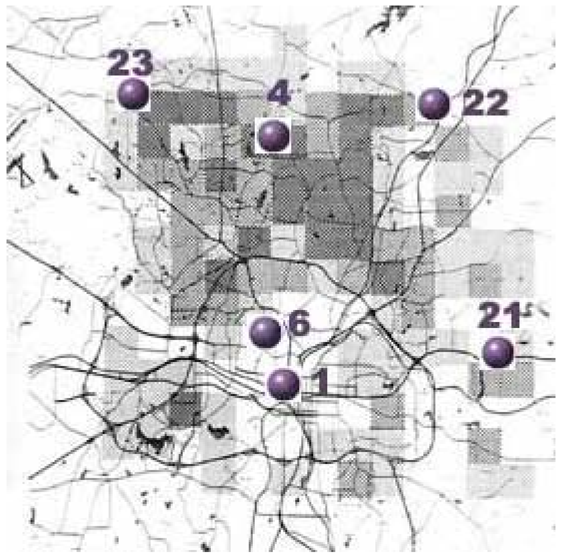
The nature of crime in a city, the nature of neighborhoods and the frequency and seriousness of the crime problem vary across communities. Techniques of using street layout to address this issue will vary as well. Oscar Newman, an architect whose "Defensible Space" concepts have been used since the 1970's to address crime problems through better design, is an advocate for defensible neighborhoods. Many crime-problem areas in the US are in urban neighborhoods wherein streets are often part of the original grid that characterizes most older cities. Newman believes that establishing defined neighborhoods by breaking up the grid can contribute to a feeling of safety and ownership of the streets by the residents. The illustration to the right shows how he suggests the grid ought to be broken down, by gates and physical disconnections, into defensible neighborhoods. Police departments generally endorse the idea of self-policing through techniques like this and community watch programs, but these techniques form a double-edged sword.

Russell Higgins lives in the older Chicago suburb of North Beverly. His community embarked on a safety and defensibility program by following the Newman model and creating "diverters", disconnections in the middle of formerly-through grid streets that either force the driver to turn around or to make a left or right turn. Mr. Higgins, who unfortunately lived on one of the streets that were left as through streets, saw the traffic on his street go from 350 vehicle trips per day to 2000 after the diverters were constructed. He also related two incidences where emergency service providers were foiled in their attempt to respond to a call. The first was a robbery where the suspect simply hopped out of his vehicle and ran across a diverter into the next block. The police cruisers who were following attempted to cut him off, but the diverters effectively ensured his getaway. Also, Mr. Higgins relates a story of an ambulance driver sent to a life-threatening emergency who got to the correct street, but because of the diverters, became lost and had to call for help, substantially delaying response to the call. As long as the primary mode of patrolling is by police cruiser, the advantages of community surveillance and access limitation inherent in the "defensible neighborhoods" concept may be outweighed by the inability of the good guys to get to the crime when it does occur, or at least to have a presence through regular patrols.

Fire Response Research Project

Methodology

This project required a GIS analysis of fire response areas based on a 1.5 mile access reach. Streets were mapped using a GIS network analysis program to 1.5 miles from the station, and were buffered to capture abutting parcels. The Wake County data records were then analyzed for these parcels to determine the acreage of non-residentially zoned property and the number



Cul-de-sac Density Map showing locations of Fire stations used for response area test. Stations 1 and 6 are located in a relatively dense grid of streets established prior to 1950. Stations 21-23 are in outlying areas in a relatively disconnected network of streets. Station 4 is in a typical collector and cul-de-sac network established in the 1970's and 80's.

of dwelling units abutting streets within 1.5 miles of the fire station. 6 fire stations were chosen. Two (stations 1 and 6) were located in an older part of the city where the street pattern was quite well interconnected, where the utilization of dead-end streets was essentially non-existent, and where the grid was relatively dense. Station 4 is in the center of the 1970's-1980's development area of Raleigh, an area essentially built-out but with some vacant land remaining. The street interconnectivity pattern here is not as consistent as 1 and 6, and many more dead-end streets were constructed. Areas 21, 22 and 23 are in the area of the city where development is currently active, with most existing development having been constructed in the late 80's and early 90's. Street interconnectivity is limited around these stations. Many dead-end streets have been utilized.

Land within the response areas for stations 1 and 6 is essentially built-out, though some un-developed or under developed property still exists in these response areas. Land in response area 4 includes more vacant land than 1 and 6, but less than stations 21, 22 and 23, which are located in actively-developing areas of town. The vacant tracts were removed from the analysis of land use for these stations. To account for relative areas of developable land a factor of 1.6 was applied to the underdeveloped fire response areas 21, 22 and 23, and a factor of 1.3 applied to fire response area 4 based on an estimate of the potential further development within 1.5 miles.

Results

In all cases, even after factoring for potential future development, the coverage of areas 1 and 6 (high degree of interconnectivity and a relatively dense grid) far exceeded the coverage of fire response areas that had a less-interconnected street network (more than double from least to most covered). Even discounting the density of development in these areas, the raw acreage covered in each case confirmed the greater efficiency in fire response coverage for areas with better street interconnectivity.

Station	Acres Commercial	Dwelling Units
1 & 6 (Avg.)	445	5591
4	186	2873
*1.3	242	3735
21-23 (Avg.)	68	1105
*1.6	109	1767

Station	Total Acres Covered
1 & 6 (Avg.)	1940
4	1256
21-23 (Avg.)	870

How Dense a Grid? Some Research...

Some interesting facts comparing older Raleigh neighborhoods with interconnected streets (A) to similar residential neighborhoods built in the 70's and 80's on a typical collector / cul-de-sac pattern (B):

Typical acreage circumscribed by through streets:	Linear feet of connected street relative to linear feet of non-connected street:
A 14 acres	A 9:1
B 45 acres	B 1.5:1

In both cases a grid exists. Reasonable traffic flow demands some sort of east-west and north-south connectivity. The real question is how much? How dense should the grid be?

Raleigh Department of Transportation staff attempted to analyze this by using a TRANPLAN model to distribute traffic on theoretical grids as follows:

- 6000' x 6000' (about 1 Square Mile)
- Bounded externally by thoroughfares
- Typical suburban density (~4 DUs / acre)
- Subdivided into 64 TAZ's (8 x 8), 10 acres each, 40 DU =400 trips per day
- 4 grid sizes (750', 1500', 3000', "Typical")
- Several variants of each size tested

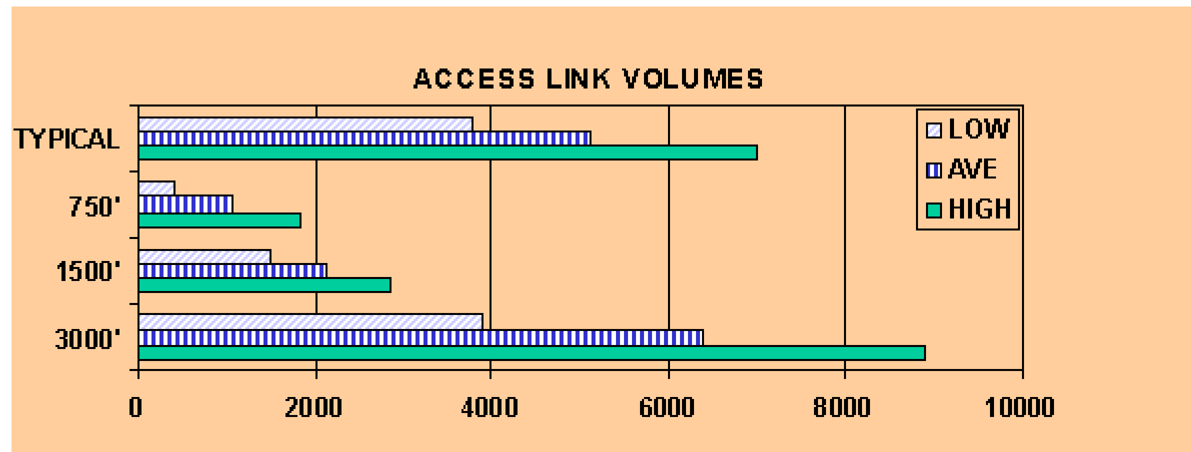
External trips were distributed as follows:

External Trip Attractions:

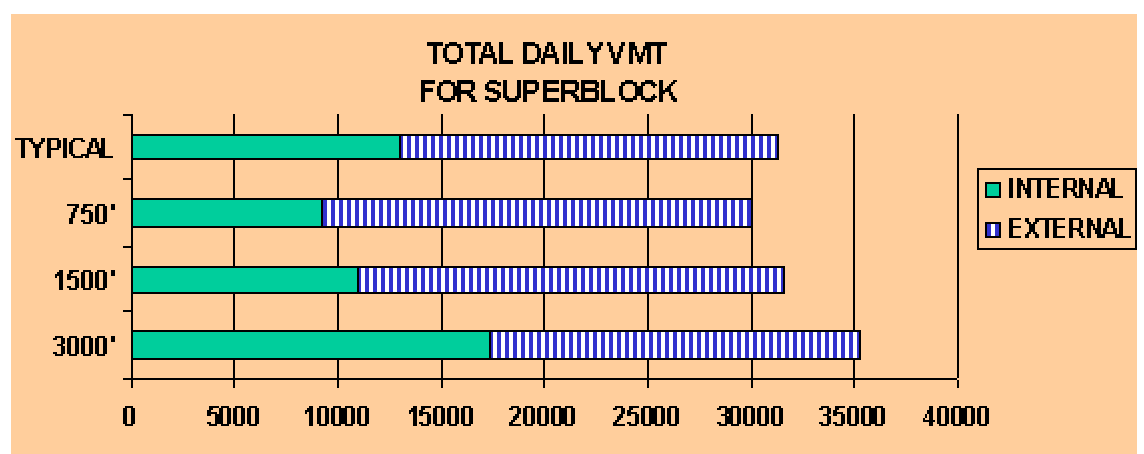
- **Balanced: 12.5% to each cordon point**
- **Unbalanced: 60% to south, 40% to north**
- **No External - External "Through" Trips**
- **100% Minimum Path Assignment**

Results

Reducing grid size gets traffic to adjacent thoroughfares faster, resulting in lower and more balanced internal street loads.

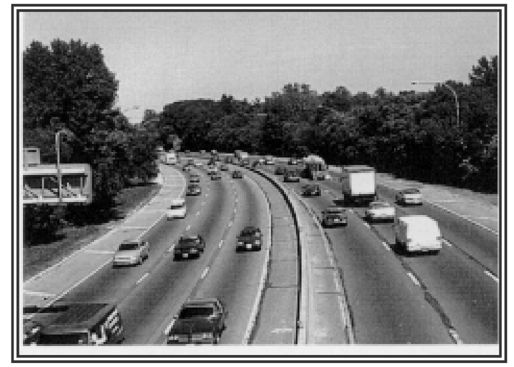


Reducing grid size from 3,000’ to 1,500’ achieves significant benefit; reduction to 750’ is not worth the added construction cost.

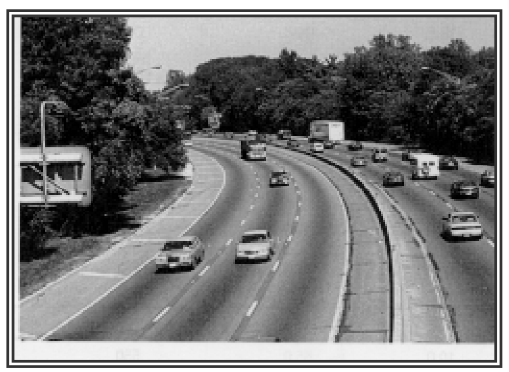


Examples of Level-of-Service (LOS) Conditions on Typical Freeway Segments

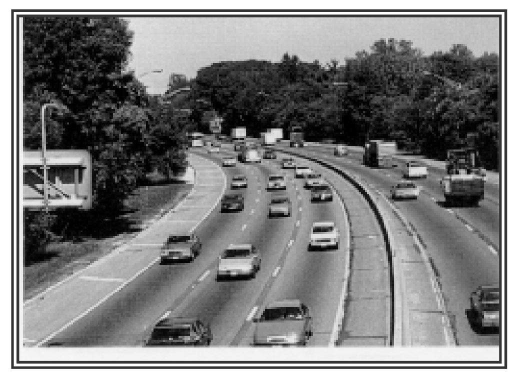
LOS A



LOS D



LOS B



LOS E

LOS C

LOS F

SOURCE: *Highway Capacity Manual 1997*, Transportation Research Board

DEFINITIONS

Average Daily Traffic (ADT)

The average number of vehicles that travel on a given section of roadway in a 24-hour period.

CAMPO Thoroughfare Plan

An official map of existing and future thoroughfares (major and minor) designated within Wake County (incorporated and unincorporated areas). CAMPO is an acronym for the Capital Area Metropolitan Planning Organization which is a federally mandated committee with one representative from each of the municipalities in Wake County who also serves on the elected board or council for that municipality.

Capacity

A measure of the maximum number of vehicles that can pass a point in a given amount of time.

Cross-Sections (Profiles)

An illustration of the horizontal roadway features which may include lanes, parking, median, verge, sidewalks, and bicycle features and dimensions.

Level-of-Service

A term used by transportation professionals to define the operating characteristics of a facility or system uses qualitative measures determining a letter grade of A through F rating how well a facility is functioning, where A is the best and F is the worst. Level-of-service measures can be based on delay, speed, travel time, density, or other measures that are relative to specific analyses. Signalized intersection level of service calculations use the following criteria to determine level of service.

Level-of-Service	Control Delay (Seconds/Vehicle)
A	<10
B	>10 and ≤ 20
C	>20 and ≤ 35
D	>35 and ≤ 55
E	>55 and ≤ 80
F	>80

Source: Highway Capacity Manual 2000

The use of a universal measure allows better communication of results. Shown on the following page are examples of level of service conditions on freeway segments.

Committed Projects

Transportation improvements with funding agreements that are already being secured.

Congestion

For the purposes of this plan, roadway congestion is defined as segments at levels-of-service E or F.

Multimodal

Different modes of transportation including bus transit, rail, bicycling, walking, or driving a vehicle, etc.

Multiuse Path

An 8 to 10-foot path shared by bicyclists and pedestrians usually separated from the roadway.

Regional Traffic

In the context of a transportation plan, the term regional traffic is used to describe traffic between cities that travels through your planning area on major and minor thoroughfares. While it would be nice if all regional traffic used the freeways, little can be done to prevent regional traffic from using major thoroughfares. For this reason, major thoroughfares are eligible for state and federal funding for widening and the construction of extensions.

Traffic Signal Synchronization/Coordination

Advanced technology that allow the controllers (computers) operating individual intersection signals to communicate with each other, sending data about traffic volume and signal timing. The purpose is to minimize the number of stops and length of delays due to red lights.

Transit

Any type of local public transportation (i.e., bus system, passenger rail, shuttle services, etc.).

TIP

An acronym for Transportation Improvement Program. The TIP is the six-year schedule for how state and federal transportation funds will be allocated among competing cities for transportation projects such as thoroughfare widening and extensions.

Verge

The grass area which separates the roadway from the walkway.

Triangle Regional Model

For this study, Kimley-Horn used a mathematical model of the Triangle region developed by local agencies, CAMPO, and the NCDOT. The model uses forecasts of increases in population and jobs and translates them into the number of vehicles on the roadways. Traffic volumes are assigned to specific roadways, which can then be evaluated in terms of future need for widening. The Triangle region is split into 2,471 traffic zones in which population and jobs are forecasted.

The model assigns traffic to all available roadways, not just the closest one. As with any model, there are limitations in accuracy. First, given the long-range horizon of 2025, population forecasts can be off by as much as 15 percent for the Triangle region. For communities and zones within each individual community, the forecasts can be off by much more. Second, the relationship between population, jobs, and trip making can change over time. For example, the number of vehicle-miles traveled in the last 10 years has increased significantly faster than the growth in population and employment with one reason being that people are driving more than they used to. Lastly, the model is based on historical information that reflects our auto-oriented society.

It must be emphasized, however, that the Triangle Regional Model is the best available tool to forecast traffic in the Triangle region.

Commonly Used Modeling Terms

- ***Link***—The term link is used to describe a road in a model. Encoded in each link is information such as free-flow speed, capacity, and distance.
- ***Node—***Nodes are points at which two links connect. A node can be an intersection of a link and a link or a link and a centroid connector.
- ***Centroids and Centroid Connectors—***Centroids are the center of activity within the zone that generate and attract traffic. Each centroid has specific characteristics ranging from the number of jobs to the number of dwelling units.
- ***Trips***—A one-way trip.
- ***Internal and External Trips—***There are two primary types of trips used in modeling. The first is the internal trip. This is a trip that occurs from inside the modeled area and ends inside the modeled area. Trips that begin inside the modeled area and end outside the modeled area are external trips. External trips can also begin outside the modeled area, pass through the modeled area, and then exit the modeled area without ever getting off of the road network.

The Modeling Process

The modeling process is based on mathematical equations tailored through calibration for the Triangle region. The modeling process for Wake County uses four steps: trip generation, trip distribution, assignment, and mode choice.

- ***Trip Generation***—A process in which a mathematical model is run to create trips based on population and jobs data in each zone. Three trip purposes are used: home based work (HBW), home based other (HBO), and non-home based (NHB). These trips can either be produced by or attracted to a zone.
- ***Assignment***—The modeling process continues after trip generation with the assignment process. Through another mathematical model, trips are assigned to specific links, which is where model volumes begin to show up for analysis. Through an iterative process, trips are assigned to specific links at specific times of day. Throughout the assignment process various measures are tabulated including volumes, speeds on specific links, times on specific links, and other calculated properties. As links become congested, the travel time begins to lengthen.
- ***Mode Choice***—The next stage of the modeling process is mode choice. Mode choice is the stage where the model determines modes of travel for various trips. The modes most commonly found in models fully utilizing mode choice include rail transit, bus transit, and automobile travel. The modeling process concludes by producing data by link and node for each of the appropriate modes.
- ***Trip Distribution***—In this stage of the modeling process, trips that are produced and attracted are changed into origins and destinations. Trips are given definite ends. This means that a trip that was produced as a home based work trip in zone 1 is going to be attracted as a home based work trip in another specific zone.
- ***Assignment***—The modeling process continues after trip distribution and mode choice with the reassignment of trips that have been split into various modes based on theoretical choices made by trip makers. Through another mathematical model, trips are assigned to specific links, which is where model volumes begin to show up for analysis. Through an iterative process, trips are assigned to specific links at specific times of day. Throughout the assignment process various measures are tabulated including volumes, speeds on specific links, times on specific links, and other calculated properties. As links become congested, the travel time begins to lengthen.

Thoroughfare Paving Policy

(Wake Forest Board of Commissioners, March 1984)

The basic intent of this policy is to provide a clear mandate on the paving responsibilities for developers on projects they propose that may be affected by a proposed or existing thoroughfare. This paving policy shall adhere to the thoroughfare concept as conceived in the officially adopted *Wake Forest Transportation Plan*.

When a development site is to front on or is traversed by a proposed thoroughfare, or an existing thoroughfare that does not meet the paving width of the Transportation Plan, then the developers of said development will be required to make the improvements that are necessary to meet the thoroughfare requirements.

1. If a proposed development fronts on an unimproved major or minor thoroughfare, the developers will be responsible for paving their half of the thoroughfare along the entire frontage to meet the width requirements mandated for that type of thoroughfare as described in the Transportation Plan.

2. If a proposed development is traversed by a proposed thoroughfare, then the developer shall be required to first make an effort to incorporate the proposed thoroughfare into the project, thus making it a functional part thereof. The developer would be required to make full dedication of right-of-way and pave the thoroughfare to its full width, including the installation of all appurtenant amenities (ex ....sidewalks). If the developer can justly show that because of topography or other conditions it is not practical to incorporate a proposed thoroughfare into the project's street pattern, then the developer shall be required to post a bond for the completion of his share of the thoroughfare. If a proposed development is traversed by a proposed thoroughfare along or close to a common property line, then the developer will be responsible for the dedication of the appropriate amount of right-of-way - in this case half, and for the paving of half of the proposed street in accordance with all design standards.

Definitions

A. **Common Property Line**—A line, identifiable on the ground by survey, that separates two parcels of land with both parcels of land sharing that line as a common border and dividing line.

B. **Unimproved Thoroughfares**—Any of those streets designated as major or minor thoroughfares, loops, or connectors on the Wake Forest

Thoroughfare Plan which are existing on the ground but are not paved to full design width.

C. **Proposed Thoroughfare**—Any of those streets that are designated as major or minor thoroughfares, loops, or connectors on the Wake Forest Thoroughfare Plan which are not yet built.

Traffic Impact Analysis (TIA) Guidelines

(Excerpt from, Town of Wake Forest Manual of Specifications, Standards and Design, Section 2)

The following guidelines will assist staff and developers to determine the requirements for traffic impact analyses for new development. The purpose of this material is to provide guidelines to ensure that property owners and developers are treated equitably, and that the appropriate level of analysis is performed to allow staff, the planning board, and the Town Council to evaluate the traffic impact of proposed new development. The following table divides development into categories, for which the level of analysis is defined following the table.

Land	Density		
Residential Office	<100 units	100 to 500 units	>500 units
Office	<50,000 sf	50,000 sf to 350,000 sf	>350,000 sf
Hotel	<100 rooms	100 to 500 rooms	>500 rooms
Industrial or Warehouse	<150 employees	150 to 1,000 employees	>1,000 employees
Retail/Shopping Center	n/a	<100,000 sf	>100,000 sf
Other	<100 peak hour trips	100 to 500 peak hour trips	>500 peak hour trips
Level of Study Required	None, unless located in area of special concern	Standard TIA	Enhanced TIA

A Traffic Impact Analysis (TIA) is to be prepared and sealed by an engineer registered in the State of North Carolina and specializing in traffic or transportation, with experience in preparing TIAs.

A standard TIA includes the following elements:

Abstract or summary—summary description of proposed development, location, traffic generation, existing and future conditions (level of service), and recommended improvements. The report should not exceed two pages and preferably limited to one page.

Description of development—describe acreage included in development, existing and proposed land use, existing and proposed zoning, proposed density (number of houses, square feet of development, etc.)

Study area—generally ¼ mile to ½ mile from each proposed site access along roads accessed by the site. This area may, in a few cases, be greater if the site is on a road with no intersections within that distance.

Site location—include location map showing site in relation to major streets and at least one-mile radius from site.

Traffic generation—indicate number of trips generated by site daily, AM peak hour, PM peak hour (AM peak hour may be omitted for retail uses which are not expected to generate significant traffic volumes during this period). Indicate internal or pass-by traffic generation if appropriate. For rezoning, indicate traffic generation under existing zoning as well as proposes zoning. Indicate source of trip generation rate, land use code, and units used to derive generation.

Trip distribution—indicate percentage distribution of trips, by direction, within study area and method used to obtain.

Access location(s)—location of planned streets or driveways and access to existing streets. Indicate other streets or driveways within study area, including those across the street. Indicate coordination with NCDOT where appropriate.

Existing road and traffic conditions—street laneage and classification, traffic control devices, existing daily traffic volumes within study area. Show traffic volumes and level of service of signalized intersections and proposed site access points within study area during AM and PM peak hour (PM only for retail). Include work sheets or computer printouts showing counted traffic volumes and level-of-service. Illustrate in figure(s) showing peak hour volumes, lanes, and level of service. For unsignalized intersections, show level-of-service for individual movements. Discuss transit service if applicable. Discuss accident history, if appropriate.

Planned improvements—discuss and describe any planned road improvements in the study area of which could affect future traffic. Note whether project is shown on thoroughfare plan, collector street plan, or NCDOT TIP.

Future Conditions—same as for existing conditions, plus site traffic assigned to driveways or access points, for condition with full build-out of project, at build-out year. Include growth in background traffic due to other approved developments or to general growth in area. May show more than one phase, if project is to be phased. Discuss any conflict with other driveways or streets, queuing problems, potential safety problems.

Pedestrian facilities—indicate location of existing and proposed sidewalks and crosswalks, internal pedestrian paths.

Recommended improvements—indicate improvements required for access points and signalized intersections within study area to operate at acceptable level of service (D or better). These may include site access, internal site circulation, signalization, signal modification (retiming, additional phases), lane modification or additions, or street widening. A signal warrant study is not required but may be included as supporting documentation where a traffic signal is requested. Note: showing recommended improvements does not necessarily indicate responsibility for improvement. Report may indicate which improvements are due to development and which are due to existing problems or other growth in traffic, and may suggest responsibility of developer or of other parties for improvements. Proposed improvements should be shown schematically on figure.

An enhanced TIA includes all of the elements of a standard TIA plus the following:

Study area—generally from 1 to 3 miles from each proposed site access along roads accessed by the site. The extent of the study area should be discussed with Town staff prior to initiating the TIA.

Internal circulation—review internal circulation patterns and note recommended changes.

Trip distribution—use of a computer model for distribution may be desirable for major projects

Future conditions—projects in this category, other than perhaps shopping centers, are likely to be phased. It is desirable to show conditions at end of planning period (generally 20-year or horizon used for thoroughfare plan).

Recommended improvements—for major projects, these may involve changes to the thoroughfare plan or collector street plan. The project may include the construction of portions of thoroughfares within or adjacent to the site.